CERAMICS

NOVEMBER
1951

o. 33 Vol. III

LONDON

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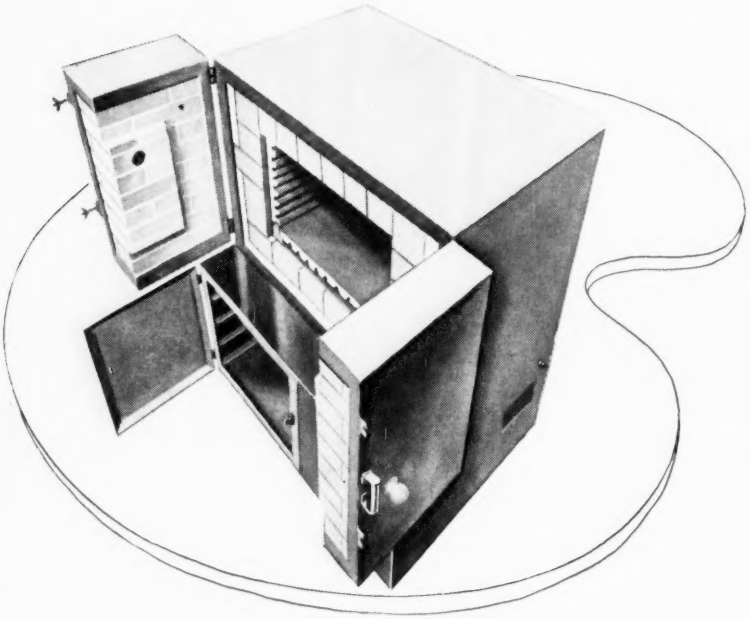

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FEATURE ARTICLES

MISCELLANEOUS

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Ceramics

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MONOPOLIES OLD AND NEW

MUCH play is being made at present upon the alleged nefarious activities of the Electric Lamp Manufacturers' Association. On the Opposition benches in Parliament one reads speeches reeking with righteous indignation, and one can picture in one's mind the long fingers of scorn which are pointed at the capitalist group who are accused in the most blood-curdling tones of being bludgeons upon the people.

Nevertheless, electric lamp manufacture at the worst is but a partial monopoly, for there are a number of capitalist organisations outside the ring who are making steady business. It is possible to go into the British equivalent of the "5 and 10 cent store" and buy a lamp for a bob!

Yet such is the partisanship of politics that the same Opposition who are proud in their boast of representing the people, seem to overlook the monopolies which they themselves have created; and indeed they are not partial but complete. It is not possible to buy cut price gas, cut price electricity, cut price coal or cut price railway transport or, presumably soon, cut price steel anywhere in the United Kingdom. As far as the buyer is concerned it matters little whether the monopoly is State controlled or privately manœuvred; surely both are equally distasteful to him if he has to buy over the odds. The position becomes fatuous in the extreme when one monopoly which is regarded as right is ignored, and another monopoly which presumed wrong is decryed.

Stoke-on-Trent has suffered at the hands of a State monopoly. Manufacturers were encouraged to install relatively new plant and equipment in the form of tunnel kilns to be operated by gas, and having been offered a preferential tariff have costed their jobs. They looked at the capital costs and looked at the running costs and decided to risk their capital in the investment. Having done this in the national interest, their running costs are suddenly increased because gas prices increase and their differential is correspondingly lower. They are not in the fortunate position of the person who can buy an electric lamp outside the ring, for there is only one purveyor of gas in the potteries, and in spite of consultative councils, in spite of very strong cases which are presented, nevertheless the manufacturer has little alternative but to pay.

This means higher prices for pottery exports, in a market which is already hardening by the competition from Japan and Germany; and less pottery exports mean less food imports. So it goes on!

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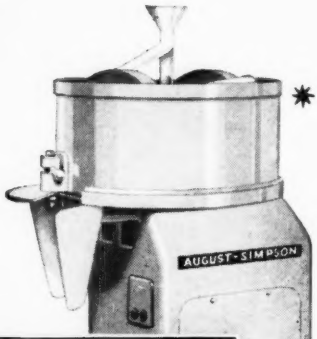

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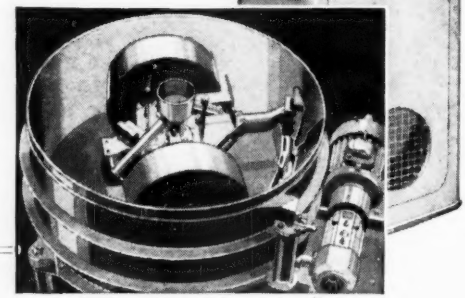

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August's LIMITED

COMMENT

by ARGUS

I FELT this column was getting too serious. The ebullitions of the politician were taken much too consequentially. I sat down one day and thought to myself that these boys in Westminster cannot really expect people to take them seriously. After all they live by wind; they need never have done a day's work in their lives, and as long as they have a pair of bagpipes for lungs, in the words of the popular song—"They'll get by."

A House Magazine

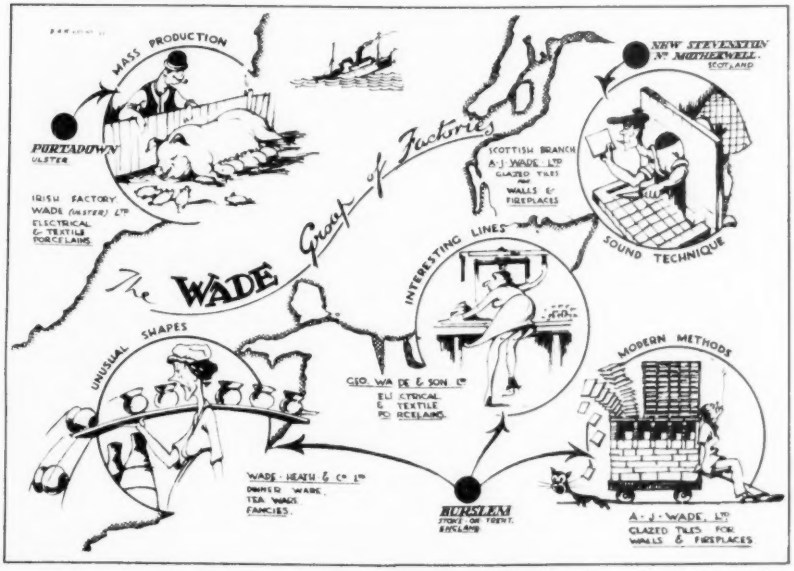
Whilst pondering this, on to my desk came the first issue of the Wade Group's house magazine *The Jolly Potter*. Humour is a most difficult thing to maintain, and if the editor of *The Jolly Potter* can maintain that of his first issue it is well worthwhile. The extrusion of "export" and "home" products by Barlow on the front cover is a stroke of genius, and with the permission of Wades we have reproduced another of Barlow's sketches dealing with aspects of their business. As a house magazine it carries something for everyone—a story of the Wade Group; a link with the past; a technical description of their new glost tunnel oven and a most amusing and witty article by H. D. Robinson on "Why Potting is so Different!"

Read the following, which appears under the heading "It Doesn't Make Sense":

"Theoretically it is bad practice to make a dried clay article wet again as it may cause it to crack.

"In practice a one-fire article is dipped in glaze in the clay state and it doesn't crack.

"Theoretically to have a good glaze fit, the body and glaze must have very nearly the same coefficient of thermal expansion. This is impossible to obtain, therefore it is not possible to glaze a piece of pottery successfully!



(Courtesy, Geo. Wade and Son Ltd.)

"Theoretically it is impossible to make a teapot by throwing and turning the body, casting the spout and pressing the handle since the difference in the shrinkages of each part will lead to a crack where they are joined together. In practice, thousands upon thousands of perfectly good teapots have been made by this method."

The various works in the Potteries, Scotland and in Northern Ireland are not overlooked, and they make great play of "Festival '51," which although many might doubt as being a work of art has nevertheless turned out to be a first-class piece of publicity for Wades. And after all, if the clever boys who are architects, and the other clever boys who are scientists, cannot occasionally do something which helps the salesman on his hard, hard road, it is a pretty poor tale.

At any rate congratulations to Miss Cecily Perrins the editor and to all her able assistants: Mr. J. Bamford, Mr. G. A. F. Stuart, Mr. Robert Barlow and Miss S. Dempsey.

C.I.D. Annual Report

Simultaneously with Mr. Churchill's spur towards economy there has been issued the Sixth Annual Report of the Council of Industrial Design covering the period from 1950-1951.

What useful purpose the Council has served, measured on the utilitarian scale of the present British economy, is difficult to assess. Broadly speaking during the period it spent some £260,000 of which His Majesty's Government granted £253,000. The Council has entered the trade and technical press field, and its effort for the year in question brought it in a revenue from this source, namely sale of its publications, of some £13,000. On the other hand the publications and their promotion cost £33,000 so that leaves them £20,000 in the red. I assure you that Arrow Press could not work on this basis, but then we have no kind, benevolent uncle who is prepared to let us be frivolous to this extent. Official salaries came out at about £120,000, office expenses at £37,000.

One questions whether for the expenditure of a cool quarter million the Council of Industrial Design has paid for its keep. It has distributed freely to museums and such places a series of exhibits of doubtful value. The *Design Review* which was devised to help the staging of Festival Exhibitions ought to die, but the Council believes that it will give useful value to buyers, retailers and manufacturers as a permanent feature of the Council's activity. Frankly this does savour not of jobs for the boys but keeping the jobs for the boys! Exhibitions cost the Council some £10,000 during the year. There is a much-vaunted stock list which is a photographic record of some 20,000 items drawn from 5,000 firms. No doubt they are now well covered with cobwebs!

Out by the Roots

This Council of Industrial Design has for quite a period been a neat little nest where the architects and their confrères have been able to browse in safety and security. It has not, and never will, give anything like commensurate value for its cost. In the utilitarian economy recently defined by Mr. Churchill the Council of Industrial Design does not want pruning: it wants cutting out by its roots!

There is an exhibition presented by them entitled "Scandinavia at Table." No doubt the children's table in Denmark, the tea table in Norway and the birthday party in Sweden will make some interesting novelty. We have had a lot from the Council of Industrial Design recently upon Scandinavia and I gather from under the table talks that a few of the staff spent their holiday there. The main thing is that this Welfare State idea is maybe new to us but not so new to Sweden. Folks like the Council of Industrial Design are really looked upon in Sweden as being important and their views are seriously considered, for this is what the Welfare State has done to Sweden!

Sweden Today

Go and live there, work with the people, see how they live, for they provide a mirror for Britain the way we are going. The gilded gifts of the Welfare State have been known pretty well to all Swedes who were 15 in 1925.

Those in search of the real Sweden will avoid the cakey Stockholm. Go to a small industrial town like

Norrkopping (of football fame). There you will see that the Welfare State has converted Sweden into a nation of flat-dwellers, forever craving after some plant life to cultivate and having to be content with some creeper on the wall or a window box looking out into the street. This in spite of the vast grassy slopes which surround these flats. No gardens and no allotments. Nearly half the population have two people per room. They have constant hot water systems which are shut down for 6 months of the year. Hot water is a luxury in Sweden from April to September. Go, jump into a lake is their Government's idea of keeping clean.

We would call Swedish furniture—utility furniture. There are few cinemas, no palais de danses for the State has conditioned Swedish youth that such pleasures are escapist. Their radio has little or no light music or variety—mostly doleful dirges and the cultural pronouncements we associate with the Third Programme.

State worship has been truly inculcated into Swedish young men and women, and what has it produced?

Future Wives

Look at any office turning out in a small industrial town and you will see dowdy and frumpish girls. As good future wives they make many of their own clothes and they are a living advertisement for home tailoring! They neither wash their hands nor powder their noses from the time they enter the office in the morning till they go home in the evening. Their hair is scraggily tied back, and the woman who indulges in cosmetic and beauty aids is condemned as frivolous—the worst qualification for the wife to be!

Each boy has his laced pillowslips and sheets bearing his initials, provided by a fond mother, which he proudly keeps throughout his life.

The Swedish State controls liquor and tobacco, neither of which are encouraged. Thus prices of both are high (as they are in Britain). You must queue for your month's ration at the liquor shop and the ration is determined by the size of your pay packet. There are no public houses or bars and you cannot buy even a humble glass of beer without consuming a meal. Tobacco, the State says, is a costly import and the majority of young Swedes no longer smoke. Petrol is another import and so the number of cars on the road is small.

One of the most depressing sights is to see a crowd of young men sitting outside a wayside cafe fresh from a game or a country walk sipping away at small glasses of lemonade or milk.

Sweden has had a Labour Government long enough to have brought the Welfare State to its logical conclusion. But the men lack guts, are effeminate in our eyes and are mental cowards. The much vaunted Swedish work output is gloriously over-rated for although they start at 8 o'clock in the morning, their task is done with the leisurely pace of the farm labourer in his non-busy periods.

State sponsored cultural organisations warn men not to marry the glamorous girl. The Swede has got his Welfare State, he is insured from the cradle to the grave but in exchange he has sacrificed every atom of individuality. Women have become dowdy frumps: sexual promiscuity, without expense to the male, has gone ahead by leaps and bounds and church attendances have dropped even more than in Britain. Political consciousness is dead, and the young Swedish man or woman has now become a successful worshipper at the "State" shrine. The Swedish Institute describes its Labour Prime Minister as a "young intellectual who has risen rapidly to the premiersnip through various stages of Government service. (More shades—this time of Messrs. Gaitskell, Wilson and so on and so on.)

In Sweden we have the logical end of the Welfare State. There is the nation which the Fabian Socialist would have us believe is worthy of emulation; of which Mr. Morgan Phillips is loud in his praises, and which the C.I.D. thinks worthy of exhibition.

And to those who doubt how far we have gone in their direction in 7 years. Beer and tobacco now expensive luxuries; cosmetics taxed to death; pleasure motoring killed; a radio Third Programme; inexperienced intellectuals in command of the nation and Mr. Gaitskell recommending an occasional 6 in. of bath water.

BODY PREPARATION BY DRY MIX METHODS

(SPECIALLY CONTRIBUTED)

THE difference in methods of body preparation used in this country and in America are striking. Whereas in this country the emphasis is on mixing the clays in the form of slips, which can then be lawned and magnetted and finally pugged to produce the right plastic consistency, the method used in most American factories is to mix the materials in a dry state, afterwards adding the required amount of water to produce either a material suitable for dust pressing, or for plastic making. Even for dust pressing the method used in this country involves the production of plastic press cakes, which are then dried out before grinding and tempering with water.

Advantages of Dry Mixing

The advantages claimed for the dry mixing method are as follows:

1. Less equipment is required, and hence there is a saving in labour, power, and maintenance costs.
2. It is easy to change from one type of body to another using the same plant, since all that requires cleaning is the mixer. There are no arks, blungers or presses to clean.
3. Since only the mixer is involved, small batches of a body can be made with little trouble.
4. The working conditions are cleaner and better, since only small quantities of water are involved and there are no slip houses.
5. There is a great saving in time in body preparation, which means that the output from a plant can be increased, and thus lower the production costs.

In connection with these advantages the following statements are typical of the claims made for dry-mixing plant by an American firm of ceramic engineers:

(a) There is an increase of 79 per cent. in man-hour production over wet-mix methods.
(b) A 54 per cent. increase in hourly mixing capacity.
(c) A reduction of 44 per cent. in the horse power required to drive the plant.
(d) Floor space requirements are halved.

These appear at first sight to be very solid advantages, so that one is inclined to wonder why the method of body production has not gained rapid adoption outside the U.S.A.

Disadvantages

The disadvantages are briefly:

1. The clays must be in a dry disintegrated condition and preferably "air-floated." This means that they have been classified by an air current. Production of such clay is considerably more expensive than for ordinary clay, in fact at present the cost in England is double, though it may be possible to reduce this somewhat by bulk handling.
2. The dry mix method provides no means of dealing with impurities such as iron compounds and soluble salts. The latter are usually dealt with by judicious addition of barium carbonate, while the former are ground to a size, which is stated to give no trouble with specking.
3. British potters consider that wet mixing methods develop plasticity and give better mixing of the body ingredients than does the dry-mix.
4. The problem of handling dry materials such as flint.

Quality to be Considered

Probably time will decide whether American methods have any application to our types of body, particularly for quality ware. At present there seems little tendency to scrap the

traditional methods and machinery, at any rate until it can be proved that the quality of the ware will not suffer, and it cannot be said yet that this point has been proved, indeed some of the older American potteries use methods similar to those of this country. For some types of ware there may be very solid advantages in changing to dry mixing, and now that air-floated clays are becoming available in this country it would be interesting to see what results could be obtained with them.

Preparation of Air-floated Clay

In the meantime it may interest readers to have some account of the method as detailed in American ceramic literature.

The preparation of air-floated clays is described by R. C. Meeker (*Bull. Amer. Ceram. Soc.* **18,** 318, 1939). The problem was a threefold one: (a) to handle the crude clay so as to avoid contamination; (b) to dry the clay so that it could be ground economically without impairing plasticity and (c) to use equipment that would ensure a uniform and clean product. With these aims in view this procedure was adopted. The ball clays were hand selected at the mine, and placed in bins which prevented accidental contamination, and in which part of the moisture was removed. The clay was then given a preliminary grinding in a disintegrator and then passed on a conveyor over a magnetic pulley which separated the tramp iron (Fig. 1) and thence to the mill where the final grinding occurred. This is a series of four vertical rollers which rotate on horizontal shafts in a pan. The clay is broken up by being squeezed against a bull ring. Heat for drying during the grinding operation is provided by filtered hot air from a heat exchanger, heated by an ordinary furnace.

The ground clay is carried off in the air stream to a classifier. The oversize particles are returned to the mill for grinding and the rest is collected in cyclone dust catchers from which it is fed in weighed amounts to paper bags or to special cars.

In the American process described the hot air entered the mill at 700° F., and the finished clay was delivered at 100° F. Trials run at higher temperatures, up to 1,000° F., had no apparent affect on the clay properties. Fineness of grinding was controlled by the air velocity in the mill and by adjustments to the classifier. In this way the product could be changed from a 60 to a 300 mesh, though with clays this ultimate limit has not been attempted.

A typical screen analysis of ball clay suitable for dry mix tile and porcelain bodies is given as 4·5 per cent on 80 mesh, 5 per cent. on 100 mesh,

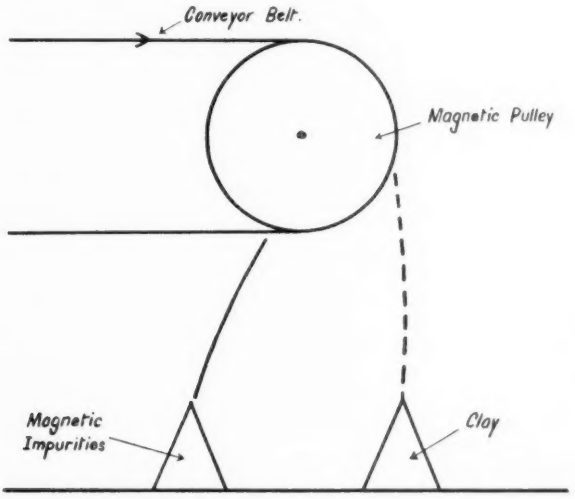


Fig. 1

9 per cent. on 150 mesh, 10 per cent. on 200 mesh and 71·5 per cent. through 200 mesh. Average moisture content is 3-5 per cent.

Bulk Handling of Clay

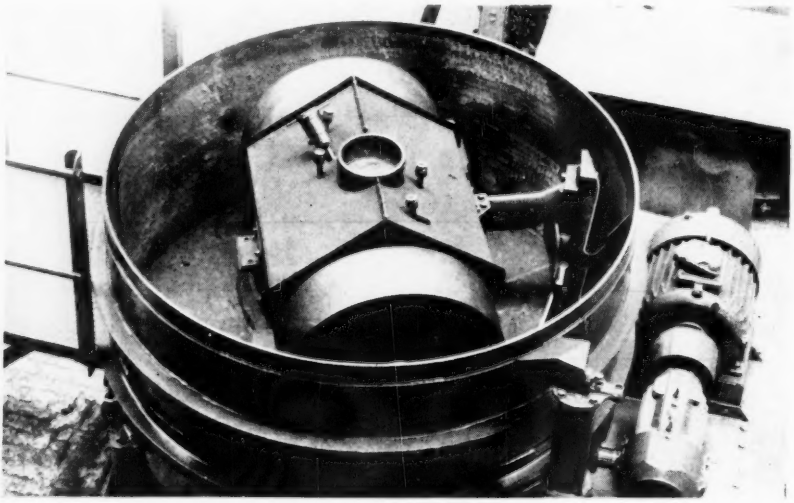
Having arrived at the air-floated clay it is interesting to see how this is handled from the producer to the pottery plant. Handling fine clay dust in paper bags is an expensive business, as the bags are not cheap and are not returnable. American manufacturers commonly handle the clay in paper lined rail cars or in sealed paper bags (cf. *Ceramic Industry*, **50**, [3], 110, 1948). The latter are susceptible to loading by fork lift trucks.

Where the material is handled in bulk, however, more spectacular methods are available. Thus we have hopper cars which dump the load straight on to conveyors placed below the rail track, which carry it to silos. Then there are vacuum and compressed air pipes to either suck or blow it into silos, in the same way as grain is handled. These are extremely easy methods of handling, and get over the dust problem. On a smaller scale cars may be emptied by small mechanical shovels or by bucket elevators. Overhead silos save floor space and enable batches to be mixed by gravity feed to a container on rails, or on a monorail. This then tips the batch into the mixer. This operation can be made fully automatic.

Dry Mixing Plant

The dry mixer consists of a stationary pan in which the heavy rollers run around. These mullers can be adjusted to a convenient height from the bottom of the pan, and ploughs are used to clean the periphery and the pan bottom, so that the material is forced under the mullers. The latter are fitted with scrapers. The ingredients are ground to pass a 200 mesh lawn and are placed dry in the mixer and thoroughly mixed for about 4 min. Thereafter the water is sprayed on. The following description of the making of dust for electrical porcelain may be taken as typical of the method (cf. *Ceram. Industry* **31**, [1], 25, 1938).

All the raw materials were air-floated and received in 100 lb. bags. Each mixed batch weighed 600 lb. and several of the materials were added straight from the bags, without weighing, into the batch hopper. The batch was passed over a magnetic pulley and then loaded into the mixer. In this case the batch was mixed for 8 min., the first minute being dry, and a



A No. 2 size August-Simpson mix-muller

further 7 min. after adding the water; which was accurately measured from a tank and sprayed on. In this case the batch weighed 600 lb. and the water added was 13-14 gal. or 16 per cent. by weight. Altogether six batches per mixer were made each hour, or 3,600 lb., and this with only two men. The batch was discharged through an opening in the mixer on to a belt conveyor which fed it through a disintegrator of the swing hammer type. The dust was discharged continuously from this and conveyed to batch boxes. The moisture content of each batch was checked regularly.

Comparison of Costs

A comparison of costs is appended. Labour costs have been reduced since two men now do all the body preparation (including glaze work) and can clean all equipment and change from one type of body to another in 2½ hours. The old slip house needed nine men and even when continuous filtration was adopted three men were still needed. The horse power requirements for body mixing were reduced from 86 to 17·8. Raw materials cost 7 per cent. more, but against this must be set off the fact that the clay was dry, and that the water consumption in body preparation was reduced by 75 per cent. The dry strength of the body was increased by 30 per cent. and a similar increase in strength was observed in the fired body.

Adaption of Method to Plastic Bodies

The method has also been adapted to plastic body preparation (cf. F. A. Fix, *Bull. Amer. Ceram. Soc.* **18,** 319, 1939; E. M. Rupp, *ibid.*, **18,** 317, 1939; H. Frahme, *ibid.*, **18,** 320, 1939). The dry materials are mixed first, and then sufficient water is sprayed on to give the required plasticity and the mixing is continued for a longer time to even up the moisture (possibly 12-25 min.). It is also possible to mix dry and plastic ingredients in this way. Another variation is to add clay slip to the dry ingredients to get the necessary additions of ball clay and water. Scraps can be added dry to the mixing, or may be treated separately by simply adding water and remixing.

Alternatively they can be slipped and added to the other dry ingredients instead of adding plain water.

Where plastic bodies for jiggering are being made experiments indicate that the use of air-floated clays is not essential, and that disintegrated material may be used instead, thereby cutting costs. The lumps of material discharged from the machine may be passed through a de-airing pug mill if required for plastic making or may be used without further treatment in some cases. It is often found that the action of the heavy rollers squeezes most of the air out of the plastic clay. Casting slip can also be made in the mixer. Whichever method is used absolute control of the water and other materials is essential if consistent results in the body are to be obtained.

Results of Changing to Dry Mixing

The results of changing to dry mixing methods for plastic body preparation in various sections of the ceramic industry are reviewed by F. A. Fix (loc. cit.). The tests covered vitreous and semi-porcelain ware and china. The conclusions were:

(a) Air-floated clays are essential for clean bodies, but where the clay is clean and readily takes up water it may not be necessary to use air-floated material for plastic bodies.
(b) Pugging is essential to produce a dense body.
(c) The physical properties of the body are equal to those obtained in wet mixing.
(d) Body preparation is greatly simplified.

H. Frahme (loc. cit.) considers that with stoneware the method gives a body showing greater green strength, decreased water absorption, and fewer iron specks. The other advantages of savings in costs, etc., were confirmed.

Dinner Ware Properties

R. C. Meeker (*Bull. Amer. Cer. Soc.* **17,** 435, 1938) reports on the properties of dinner ware bodies made by the dry-mix against those of a body prepared commercially by the wet method. The results are given in Table 1 and are considered to be satisfactory.

Application to Wall Tiles

R. F. Evans (*ibid.* **19,** 255, 1940) has studied the properties of wall tiles made by dust pressing using dust prepared by wet and dry mixing with different types of mixer. His results are given in Table 2. The body used was a high talc, low clay composition and the methods of preparation involved:

(a) Grinding the batch in a ball mill, lawning, magnetting, pressing, drying the press cakes and grinding and disintegrating.
(b) Mixing in a wet pan adding 8 per cent water to the dry materials. Subsequently the dust was disintegrated.

TABLE 1.

	Body *A.*	*B.*	*C.*	*D.* (*commercial wet-mix body not de-aired*)
% water	23·5	22·3	22·7	22·8
% linear dry shrinkage ...	6·0	5·6	5·1	5·5
% total shrinkage (O. Cone 9-10)	10·5	9·6	10·5	10·7
% absorption (7 in. plates) ...	12·1	12·5	4·6	9·1
Dry modulus of rupture (P.S.I.)	629	678	657	660
Fired modulus of rupture (P.S.I.)	4,290	4,620	4,870	4,690
Impact value	4·7	4·9	4·1	4·7
Heat shock 212° C. to water	No crazing	No crazing	No crazing	No crazing
12° C. (fire quenchings) ...	No dunting	No dunting	few edge dunts	few edge dunts
Autoclave test (100 lb. for 3 hours)	5 plates clear 3 dunted	7 plates clear 1 dunted	None crazed or dunted	None crazed or dunted

TABLE 2.

Physical properties (Fired to O. C. 2)

Method of Preparation	*% moisture at press*	*% total shrinkage*	*% absorption*	*Modulus rupture (P.S.I.)*
Wet process (ball mill) ...	6·0	1·63	12·15	6,692
Wet pan, dry mix	7·1	1·90	12·20	6,108
Simpson mixer—dry mix	7·45	1·23	15·25	4,173
Spiral blender—dry mix	8·0	1·04	16·50	3,250

(c) As (b) but using a Simpson mixer.
(d) Using a special type blender to mix the dry ingredients and afterwards adding water.

The wet-milled body was very white and showed no specks. The others showed a slight grey cast from very fine specks. With this particular type of body these results show less satisfactory properties for the dry mixed body than were found in the investigations of dinner ware bodies previously mentioned.

TABLE 3. ELECTRICAL PORCELAIN.

	% drying shrinkage	*Dry strength (P.S.I.)*	*% total shrinkage*	*Fired modulus rupture (P.S.I.)*	*% absorption*	*Dielectric value (volts/mil.)*
Wet mix ...	2·57	216	12·2	4,700	0·96	131
Dry mix ...	2·59	222	11·9	5,100	1·00	155

Electrical Porcelain

The effects of dry mixing in the manufacture of dry process electrical porcelain are given in a paper published by R. A. Snyder and J. D. Harnish (*ibid.* **19,** 258, 1940). The results are given in Table 3 and the authors conclude that the mechanical and electrical properties of the body prepared by dry mix were equal to those prepared using wet methods. The lower operating and maintenance costs fully justified the adoption of the method

Information on the results of dry mixing in various other sections of the American ceramic industry can be obtained from a paper by F. A. Fix (*ibid.* **17,** 35, 138) who collected the information by personal contacts or with the aid of a questionnaire. The report covers electrical porcelain floor and wall tiles, chemical stoneware, vitreous and semi-vitreous china, heavy light refractories and saggars, and casting slips. In connection with the latter the process described involves soaking the ball clay in water and deflocculent for 12 hours, screening it into the mixer, and then adding the other air-floated ingredients and mixing for 10 min. The slip is then ready for use. The report confirms the advantages and drawbacks of the process already given above, and on balance the author considers that the long list of American firms using the method proves that the advantages predominate.

ALGINATES

UNDER the above heading, Alginate Industries Ltd., of Walter House, Bedford Street, London, W.C.2, have published a useful booklet. They describe the chemical constituents of these materials which are derived from species of seaweeds and their uses for stabilising, thickening, deflocculating, creaming, gelling and film forming. Notes are given on the proportions of alginate solutions and some physical characteristics such as viscosity of the prepared solutions.

The technical service department of Alginate Industries Ltd., state that they are always ready to consider technical queries relating to the potential uses of alginates.

Richards Tiles Ltd.—Three new directors have been oppointed to the Board of Richards Tiles Ltd., Tunstall—Mr. C. K. Stott (chairman of the sister firm, Edward Johns and Co. Ltd., Armitage), Mr. A. L. Davies (sales manager) and Mr. J. Fryer (purchases manager).

DRYING TECHNIQUE

by

R. R. CLEGG, A.M.I.Mech.E., A.M.I.H.V.E.*

PART II

A FURTHER development is the continuous-band conveyor-type tunnel kiln. This consists of an extended drying compartment or tunnel through which pass one or more conveyors carrying the stock. This enters the tunnel by the uppermost conveyor and falls successively from conveyor to conveyor as it progresses through the machine, until it is finally discharged from the bottom conveyor.

When dealing with loose stock, the air stream is admitted through a single point of entry and passes either in the same direction as the stock, or in counter current. This type of through flow is subject to the disadvantages already outlined in relation to the truck dryer, plus a further loss in efficiency due to the short-circuiting of the main circulating flow, the result of uneven distribution of the stock due to falling from one conveyor to the next (Fig. 15).

Single-band Conveyors

Single-conveyor drying machines have the advantage that they give positive control of temperature, humidity, drying time and rate of intake of the stock. A simple redis-

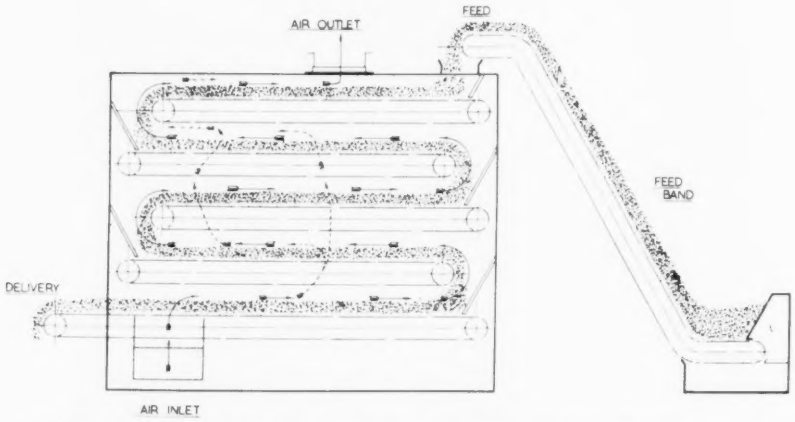


Fig. 15. Multi-conveyor machine with counter-current air flow, showing possible short circuiting when dealing with loose material

position of the air-circulating equipment will permit of upward or downward flow, or of any combination of these, along the length of the machine.

The hot air can either be admitted to the drying chamber freely or it can be kept under control by means of impact jets until contact is made with the stock surface. The choice between these two methods depends upon the stock characteristics; in general, impact jets are used for stock which can pass continuously through the chamber in the form of a layer or piece and is not subject to excessive case-

* Tomlinsons (Rochdale) Ltd.
A major extract from a paper presented recently to the Institute of Fuel.

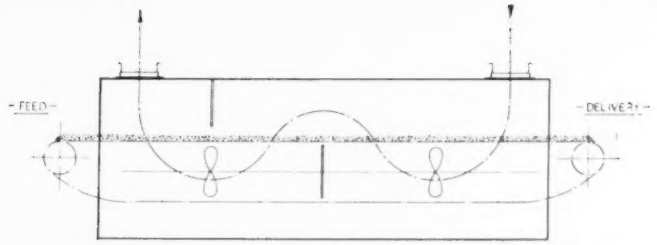


Fig. 16. Single conveyor drying machine (reversible air flow; counter-current air circulation)

hardening conditions. Impact jets may be less useful if the stock is irregular in form or is held in suspension, in which case it is difficult to maintain the control of the air stream over the whole of the stock surface.

Design Considerations

When the stock is of loose formation the band is so constructed as to present a continuous surface from the point of feed to the point of discharge. It may be fabricated from a belt of woven mesh or from a series of individual cross bands. These latter are either of woven - mesh or of perforated-plate construction and are firmly secured to the conveyor chains running the length of the tunnel.

Side guards of the moving and of the stationary types are secured to the conveyor bands and to the tunnel respectively, to prevent seepage of material on to the chains and on to the floor of the tunnel.

Except in those machines where a straight-through air flow is essential an attempt is made to pass the air stream more than once through the stock on the conveyor band (Fig. 16). The extent to which this principle can be applied is determined by the permissible capital outlay on the equipment. It finds its most extended application in the complete zonal recirculating system. In nearly every case the nominal direction of flow of the warm air is vertical—either upward or downward according to the stock characteristics of the stock. By adopting the primary and secondary system of air circulation (see Fig. 17) it is possible to provide the conditions of high temperature and velocity permissible during the constant-rate period and, by a simple redisposition of fan and heating elements, to satisfy also the conditions required by the falling-rate period.

Continuous-type Tray Dryer

Two of the principal disadvantages

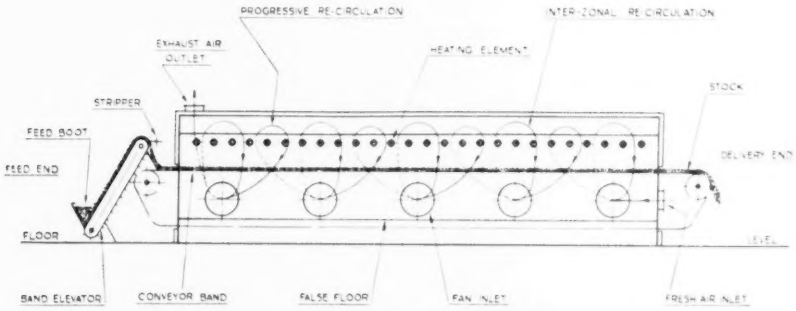


Fig. 17. Single-band conveyor dryer (downward air flow; counter-current air circulation)

associated with the operation of the tray or shelf type drying machine are: (a) it is extremely laborious and costly to load and unload the individual trays; (b) it is difficult to ensure absolute uniformity of drying conditions from tier to tier and across the projected area of the trays.

Further, as the material on the tray becomes dry, the upper layer presents a resistance to heat and vapour flow that increases with time. This resistance can be considerably reduced by agitating the stock, but it would be tedious and costly to do this manually.

To overcome these inherent disadvantages the continuous-type tray dryer was evolved (Fig. 18). This machine consists of a central circular tower carrying shelves arranged in a tier and so constructed that the material to be dried can fall from shelf to shelf either directly or by a spiral path. The tower may either be made to rotate *en bloc* against stationary scraper bars, or alternatively, may remain stationary while the scraper bars rotate across the tray surfaces.

The wet material is charged into the tower at the top and the dried product is discharged at the bottom; air is circulated between the shelves as in simple type of tray dryer.

The advantages of this machine are those to be obtained from interzonal and progressive recirculation. It is possible to arrange for the stock to be in contact with low-temperature dry air at the point of material discharge and with high-temperature moist air at the point of material entry. Further, the continual agitation of the material on the trays as it passes through the

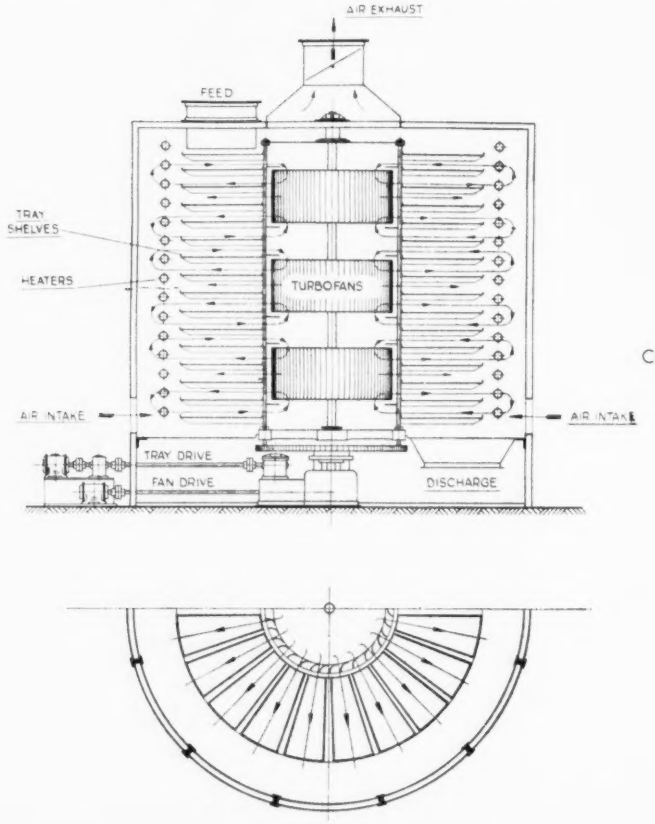


Fig. 18
Continuous-type tray dryer

machine constantly presents a new wetted surface to the air stream and thus increases the rate of evaporation.

The disadvantage associated with the machine is the fact that the material must, of necessity, cascade freely from tier to tier and in so doing must pass through the stream of moving air crossing the tray surface, so that, unless the velocity of the air stream is extremely low or the material reasonably heavy, a considerable amount of the material to be dried is entrained by the air and is deposited in the various crevices and compartments of the machine.

Spray and Pneumatic Dryers

Spray dryers are designed specifically to handle liquid stock, to dry the stock by convection and to produce a dried product in finely powdered form.

Essentially, the spray dryer consists of a mechanism for atomising the liquid stock and bringing the droplets thus produced into intimate contact with a stream of hot air whilst making provision to dispose of the dry material and to remove any which may have been entrained by the stream of hot air.

The conditions in this machine are almost ideal for convection drying, inasmuch as the globules of wet stock present wetted surface conditions on all faces, and, as they are falling freely through the stream of air, all surfaces are simultaneously in intimate contact with the heating medium, and therefore vaporisation can occur uniformly.

The rate of drying will depend on, amongst other things, the size of the globules, which is determined by the atomiser. There are three principal methods by which atomisation is achieved: (i) the liquid can be sprayed at very high pressure through a fine orifice of an atomising nozzle; (ii) a fine jet of the liquid is directed against the upper face of a disc or wheel which is revolving on a vertical axis; (iii) by using compressed air with a number of nozzles.

As the globules leave the atomiser they quickly lose their kinetic energy and fall easily through the drying chamber, through which is also flowing a stream of hot air or flue gas.

Whilst the majority of the stock may be deposited in the lower regions

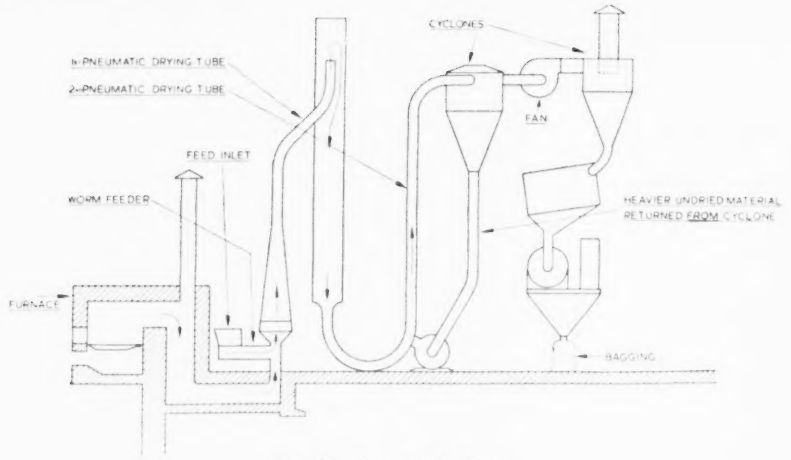


Fig. 19. Pneumatic dryer

of the drying compartment, some of the stock will become entrained in the gaseous stream and will go forward to the point of discharge. Precautions have to be taken against the loss of the product to atmosphere, and filtration equipment must be installed.

The pneumatic dryer is similar to the spray dryer in that the wet stock is entrained in the stream of hot gas passing vertically through the drying compartment (Fig. 19). By adjusting the velocity of the gases according to the characteristics of the stock to be handled, it is possible for the moving stream to select the dry material and carry it forward whilst rejecting the wet material. The latter is either maintained in a state of semi-turbulence within the heating tube until it has been sufficiently dried or else is by-passed to the feeding device and recirculated.

The gaseous products of combustion are used as the heating medium and are circulated at a high velocity through a tubular form of drying compartment which may be over 30 ft. in height. By thus bringing the wet material into immediate contact with the high-temperature heating medium a high rate of evaporation is obtained, and for this reason the machine is sometimes called a "flash-dryer."

An essential feature of this system is that the particles of wet material as admitted to the drying compartment

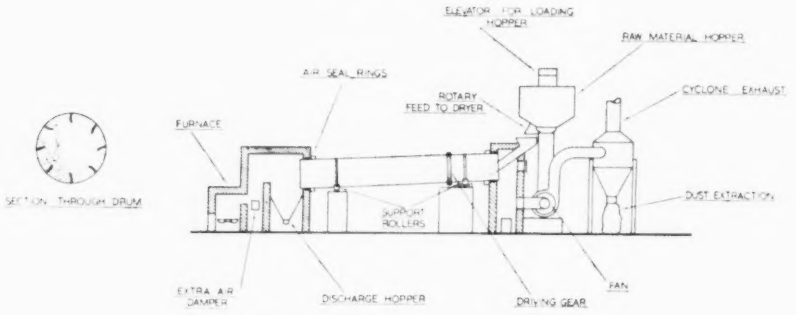


Fig. 20. Single-shell rotary dryer

should be approximately similar in size, weight and moisture content; otherwise scorching may occur.

Rotary Dryers

The rotary-type continuous drying machine (Fig. 20 and 21) is especially useful for drying materials which are able to withstand the impacts and abrasion caused by continual and vigorous cascading and which do not deteriorate materially when exposed to high-temperature conditions.

Essentially the rotary dryer consists of a horizontal tubular shell through which the stock and (perhaps) the gaseous heating stream are passed.

Depending upon the limiting temperature conditions, the hot gases are forced directly and initially through the central core of the shell or are first passed through jacketed cavities on the outside of the shell. Alternatively, the gases may be retained completely on the outside of the shell, which is then built within what is virtually a combustion chamber.

As with the tunnel dryer, the hot gases may flow either in the same or the opposite direction to the stock, and with certain specific designs a degree of interzonal circulation is possible. The shell may be made to rotate, or, alternatively, it may remain stationary: in the latter case, an independent central heating element revolves alternately through the stock and through the heating medium.

In the rotating shell dryer an attempt is made to spread the stock load uniformly over the cross-section of the shell by means of internal paddles or shelves, each of which accommodates a certain proportion of the total load and causes it to fall in a continual cascade as the drum rotates. The shape of the paddles is chosen to suit the stock to be dried. By so arranging them that the cascade effect produces a spiral action, longitudinal movement of the stock masses can be promoted, a condition which is further assisted by a slight inclination in the axis of the drum.

By so spreading the stock across the entire area of the drum, uniformity of contact between the heating medium and the material to be dried is approached. Precautions have sometimes to be taken to avoid the possibility of air entrainment, and in such cases dust separators have to be installed at the point of air discharge.

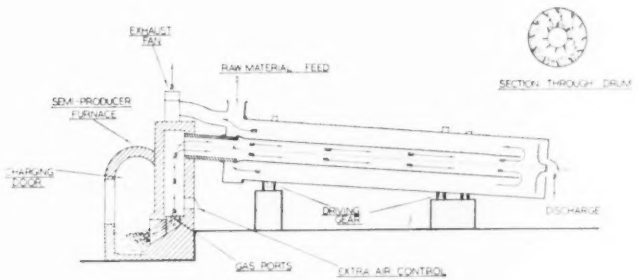


Fig. 21. Double-shell rotary dryer

If the air stream passes through the centre of the shell the machine is essentially a convection dryer; although conduction from the shell and from the flights, together with a degree of internal radiation, assists in the overall heat transfer.

In those machines in which the heating medium is retained on the outer surface of the shell, the drying process depends upon conduction assisted by radiation (Fig. 22).

In the static shell-type rotary dryer the heat transfer is mainly by conduction. The material to be dried remains almost static during transit through the drum, being retained within the lower half of the latter so that the concentric heating elements of the rotor are partially submerged in the stock and partly exposed to the stream of hot gas flowing across the surface of the stock. For a definite period of each revolution the rotor

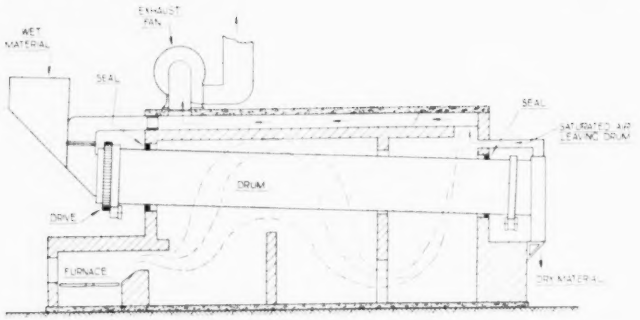


Fig. 22. Drying drum heated on outside of shell by direct gases of combustion

surface is having heat transferred to it from the hot gases by the mechanism of conduction and for the remainder of that revolution it is giving up that heat to the stock in a similar manner.

The intimate contact thus achieved between stock and heating surface ensures a high rate of heat transfer, and the agitation and disintegration of the particles of stock assist in the acceleration of the drying cycle.

Progress of the material through the shell is a result of the ever-diminishing magnitude of the angle of repose as the stock mass is reduced in moisture content.

Vacuum Dryers

Nearly all vacuum dryers are essentially contact drying machines. The whole of the operation of imparting heat to the stock is carried out within a hermetically sealed space in which a high vacuum is maintained. The result is that there is a very considerable difference in vapour pressure between that of the liquor to be evaporated and that in the ambient space, even though the temperature difference between the stock and the liquor is relatively low.

Vacuum dryers (a typical example of which is represented diagrammatically in Fig. 23) may be of the shelf-type, the continuous conveyor type, the rotary type or the drum type. They are widely used in the chemical industry and for certain food-preparation processes. The maintenance work needed to preserve a high vacuum is the main disadvantage of this type of

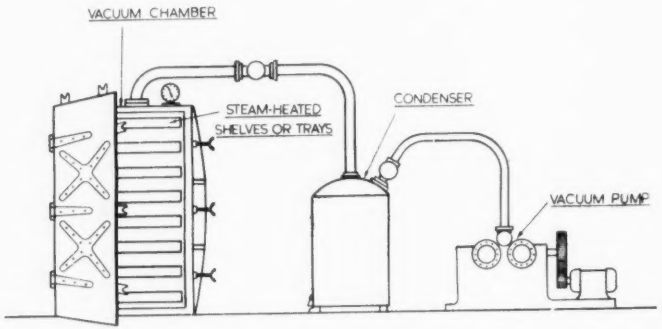


Fig. 23. Vacuum dryer. These may be of the continuous conveyor, rotary or drum type

dryer. Another disadvantage, which applies only to the shelf-type machine, is the labour and the loss of effective drying time involved in the operations of loading and unloading.

Radiant-heat Dryers

The principles involved in radiant-heat dryers differ fundamentally from those of contact (conduction) and convection dryers. The transfer of heat energy depends entirely upon radiation and absorption, i.e. radiation by the heat source and absorption by the stock.

It follows that only those bodies which possess high properties of radiation when hot should be used as emitters, while those which are poor receivers are not the best types of stock for such treatment. According to the laws of Stefan the approximate amount of heat transmitted by radiation is given by the expression:

$$Q_R = 0{\cdot}172 \times p \times A \left(\frac{T_1}{100}\right)^4 - \left(\frac{T_2}{100}\right)^4$$

where Q_R = rate of heat radiated, B.Th.U./hr.; p = the factor of emissivity; A = area of one of the two surfaces, sq. ft.; T_1 and T_2 = absolute temperature of the two surfaces, °F.

Thus it follows that high-temperature emitters will radiate far more heat than those of lower magnitude. The actual source of radiation can be heated by electrical elements or by the gases of combustion. The former are probably the most conveniently applied. Filament bulb emitters were considered most adaptable until recent experience showed that electrical resistance elements of the open type have much to recommend them.

The so-styled "infra-red dryers" are an example of this particular application. For the stoving of lacquered surfaces on metal base components, this system has proved very effective. A wave length of the radiant energy is such as to pass through the veneer of lacquer with little or no effect, the heat being absorbed by the metal base. The temperature of this base rises steeply and thus the lacquer is dried from the inner side by conduction.

On occasions it is an advantage to assist the drying potential of the radiant heat by a suitably applied convection current, for which purposes the waste products from the direct-fired element can often be employed.

The drying apparatus can be constructed on the batch principle or as a continuous unit, dependent upon the demands of output. Usually the continuous method finds favour in view of the large quantity of similar articles that have to be treated. An important feature in the design is to ensure that the flux density of the heat energy is spread uniformly over the stock surface and that "shadow" effect of the stock-loading is reduced as far as is practicable, bearing in mind that the flux density will vary according to the square of the distance between the emitter and the receiver. That is to say, if the emitter were at a point in space only a quarter the amount of heat energy would be radiated to unit surface area 2 ft. distant from the point of emission as would be received by a similar point of unit area only 1 ft. from the source of heat.

Heating Medium

In nearly every application of heat-energy utilisation in drying machinery, the ultimate source of this energy is to be found in the combustion of fuel, be it solid, gaseous or liquid in kind.

The running costs of the plant, and to a degree the relative thermal efficiency, are dependent on whether the fuel is burnt in the firebox of the boiler or in the furnace of some heat exchanger, and upon the distance between the point of utilisation and the point of combustion.

Where possible, the direct use of the gases of combustion is to be advocated since intermediate thermal losses can often be eliminated and the overall design of the equipment simplified considerably. Whether or not this is possible will depend upon the characteristics of the stock—whether the stock is such that it can be treated with the direct gases of combustion without deterioration or contamination, or whether the high temperatures so made possible can be utilised to the full extent.

If the efficiencies associated with the use of the products of combustion as a direct heating medium are to be realised, it is essential that the design and construction of the combustion chamber shall be properly executed.

Fuel Feed

The method of feeding the fuel will be determined by the type of the fuel to be burnt, but automatic stoking or firing under close thermostatic control is essential. Precautions also must be taken to ensure complete combustion before the gases from the furnace chamber are mixed with the cooler gas stream in recirculation. To the extent by which the system fails in the latter essential will particles of free carbon be deposited on the stock.

For those applications in which the furnace temperatures are permissible but direct contact with the heating gases is not, an indirect heater can be employed wherein the two gaseous streams are shielded from direct physical contact with each other by some form of heat-exchange device.

An indirect heating element is one in which the circulating air stream is completely isolated from direct contact with the heating medium, and the only change in the condition of the air stream on passing through the heater is one of temperature. For temperatures above, say, 350° F., this form of heating device is usually employed, with electrical resistance as a possible alternative, but for temperatures below, say, 350° F., saturated steam is usually employed as the heating medium. On occasions there are borderline cases where the actual steam pressure available on site is not quite sufficient to obtain the working temperature required; in which case a booster of the direct-heated pattern can sometimes be employed.

With steam and high-pressure hot water, the heating media are once removed from the actual source of heat, and those losses associated with steam-raising plants have already been suffered before the steam is fed to the drying machine proper. Where pass-out steam is used this consideration is of less importance since the heat thus available might otherwise have been lost and the overall efficiency of the plant reduced accordingly.

A further loss extraneous to the drying machine proper is in the condensate discharged. Whilst efficient

trapping and "flash" steam systems may recuperate some of this, it cannot be reclaimed wholly and must be considered in the overall plant efficiency. When using high-pressure hot water this particular loss does not occur, but against that factor must be offset the energy absorbed by the circulating pumps. The importance of efficient lagging of the steam mains and condensate returns cannot be over-emphasised.

Where temperatures are required which are higher than those obtainable from saturated steam available on site, electrical elements afford a simple alternative or auxiliary booster; in this case, however, the heat energy is twice removed from the actual source, once in the steam raising plant and again in the generating equipment.

This condition is usually reflected in a higher heating cost but this may be neutralised to some extent by a higher thermal efficiency at the drying machine proper.

It is important that a common meaning should be understood from the term "thermal efficiency." There is not complete agreement as to a proper approach. It is considered by some that the efficiency of the whole steam-raising plant (including the boiler, service lines and drying machine) should, together, be taken into considerations when assessing the efficiency of the drying machine proper.

It is argued that this will give a proper picture of conditions on site and will allow to some extent for the difference in the prime costs of the heat energy to the consumer being accommodated in the efficiency calculation.

On the other hand, it is contended that the question of thermal efficiency should be related to the machine proper, the heat and mechanical energy there absorbed forming the basis for any computation.

Whilst the first method does, to

some extent, achieve the object credited to it, the second (in the author's view) gives the more concise picture of the actual machine under consideration.

Conditions vary so much from factory to factory that it may be unfair to the designer to consider anything but the specific efficiency of the machine proper. On the other hand, it might be unfair to the user if nothing but the thermal efficiency were quoted.

The usual method of computing the thermal efficiency is to equate the amount of heat used to the weight of water evaporated, e.g. the weight of steam condensed would be equated to the weight of water evaporated, and, similarly, for coal and oil the weight of the fuel used would be so equated. With electrical resistance heaters or town-gas burners a convenient unit of energy or quantity can be employed.

It has to be borne in mind, however, that the ratio between heat used and water evaporated can only be compared when similar types of stock are under consideration.

Materials which contain a large amount of moisture and will part with this moisture readily, will give an entirely different aspect of thermal efficiency than will one in which the moisture is closely retained and in which the moisture content in the initial stage is low.

So far as steam heating is concerned some of the factors which will tend towards improving the efficiency of the machine and the heating medium efficiency, are as follows:

The steam shall be dry and saturated and free from air. The condensate shall be continuously and effectively removed, without unnecessary loss through leaking steam traps. The heating surface shall remain free from contamination, if necessary resorting to the introduction of air filters or even plain surface conduction; although if the extended surfaces of gilled pattern can be employed then it is always advisable to do so.

When computing the efficiency of the drying machine, the following sources of heat loss have to be considered:

1. The heat necessary to raise the temperature of the wet stock to the vaporising limit.
2. The heat required to vaporise the moisture.
3. The heat required to heat the air admitted to the machine to replace that exhausted in the saturated condition.
4. The heat required to elevate the temperature of the machine structure, trucks, trays or conveyor mechanism which may be continuously passing through.
5. The heat lost by radiation from the external surface of the structure.

THE AMERICAN CERAMIC SOCIETY

THE following points make up the summary of a paper by M. D. Beals, L. R. Blair, R. W. Foraker, and W. R. Lasko, entitled, "Study of Particle Size of the Opacifying Phase in Titania Enamels: 1—Change of Particle Size with Change of Concentration of Dissolved TiO_2."

1. It is possible to obtain fairly accurate particle size data for titania opacified enamels by electron microscope studies of hydrofluoric-acid-leached enamels.
2. The particle size of crystals in an anatase enamel can be controlled by adjusting the relative amount of TiO_2 incorporated in the enamel batch, large particles generally being produced at low TiO_2 concentrations and small particles at high TiO_2 concentrations.
3. The particle size of crystals in the anatase enamels under study which produced the maximum reflectance fell in the range of 0·17-0·22μ.
4. The particle size distribution of the enamel becomes restricted as the concentration of the TiO_2 is increased. At very high concentrations most of the particles fall in sub-pigmentary size ranges.

The paper, which is published in the 1st October, 1951, issue of the *Journal of the American Ceramic Society*, was originally presented at the fifty-third Annual Meeting of the Society.

CHEAPER INDUSTRIAL GAS—The Answer

AT the West Midland Gas Consultative Council meeting at Birmingham on the 12th November, Mr. G. le B. Diamond, as chairman of the Area Board announced that the request of the British Pottery Manufacturers' Federation for preferential terms in the potteries could not be granted immediately. In his statement giving an analysis of the whole matter, however, he intimated that in the forming of new tariffs the Federation's submission would be given further consideration.

Mr. Diamond's statement was as follows:

Federation's Case

On the 10th September, 1951, the West Midlands Gas Consultative Council received a deputation representing the British Pottery Manufacturers' Federation. The deputation submitted a case on behalf of its members for a reduction of 1d. per therm from the current price of gas, provided the consumption amounted to 19,000 therms per quarter. (At the present declared calorific value this is equivalent to 4,042,500 c. ft.) In response to a question, the deputation stated that, if the reduction was conceded, a marginal clause should be inserted whereby consumptions of less than 19,000 therms would not be charged more than consumptions of this amount. The Federation case was embodied in a memorandum which was handed to the chairman of the Council.

The Consultative Council decided to refer the application to the Board with a request that "it should be given careful consideration when preparing the new tariffs."

Before replying to the application, the Board desires to acknowledge the importance it attaches to its large sales to the pottery industry. The foresight shown by the Stoke-on-Trent Corporation in catering for the load, the benefit which accrues in improved working conditions in the factories, the contribution to smoke abatement in the city which results and, not least, the economic importance of pottery exports, are all appreciated. It is for these reasons that the Board has done its utmost to plan and hasten the extensions at Etruria works, which were undertaken mainly to meet the needs of the industry. More recently, a trunk main has been laid from Leek to Stoke in order to utilise surplus gas manufacturing capacity at Leek for the benefit of Stoke consumers.

The memorandum has been carefully studied and the Board regrets, for the reasons set out below, it is unable to accede to the application for an immediate reduction in price. The present margin between costs and selling prices is very small and the Board cannot afford reductions in net revenue if it is to discharge its obligations under the Gas Act, 1948. The Board will, however, undertake to give further consideration to the submissions in framing the new tariffs which, it is hoped, will be available early next year.

Comparison with 1939

For a proper consideration of the price factors involved, it is necessary to go back to the more stable conditions prevailing in 1939 and to compare the general level of prices at that time with the prices prevailing today. Taking the prices ruling at March, 1939, as 100, comparable figures in July, 1951, when the price increase in the West Midlands Area was decided upon, were as follows:

Coal	264
Coke oven gas (weighted average)	242
Gas oil	315
Labourers' hourly wage rates	204

It is not possible to estimate precisely the increase in the cost of many other materials which the Board has to purchase but the wholesale price

index prepared by the Board of Trade indicates very substantial increases.

Coal Prices

Traditionally, the Stoke Undertaking always drew its coal supplies from North Staffordshire. Unfortunately it has not been possible to obtain sufficient coal in the past 2 years from this coalfield, with the result that a considerable tonnage of North-eastern coals has had to be bought. This has had a very adverse effect on the average price of coal received. For instance, during the 12 months ended 31st March, 1951, it was necessary to import 51,545 tons of North-eastern fuel at a delivered cost of 67/4d. per ton (average), as against 55/10d., per ton from North Staffordshire Division, which is equivalent to an increase of 11/6d. per ton. The added cost to the Stoke-on-Trent District on account of this fuel for the 12 months ended 31st March, 1951, was £29,500, and represents an increased cost per ton, based on the total coal carbonised, of 2/4·2d. The position with regard to the proportion of North Staffordshire coals available is worsening and so adding to the problem of Stoke-on-Trent. It should also be noted that, on account of the additional cost of the North-eastern coal, under the relevant coal clauses in the contract, the delivered price of Shelton coke oven gas during this same period was increased by £2,800

In effect, therefore, the Stoke-on-Trent District have been called upon to pay £32,300 extra on account of the inability of the North Staffordshire Division of the Coal Board to supply local fuel and this has had a profound effect on costs. If this additional amount of £32,300 is calculated on the basis of all the gas sold during the 12 months, it is equivalent to an added cost of 0·27d. per therm.

In 1939, the Stoke-on-Trent Undertaking had some very fortunate coke oven contracts, under which they were able to acquire 54·3 per cent. of their total requirements. The terms were sufficiently favourable to enable the Undertaking to operate profitably while selling large quantities of gas at the very unusual price of 2·55d. per therm.

The following table sets out:

(a) The percentage of gas taken by the pottery industry and other consumers, and;

(b) Particulars of the sources from which gas was available in the years 1938/39 and 1950/51.

	Sales of gas				*Source of gas available*		
	Pottery industry		*Other consumers*				
Year ended 31st March	*Therms*	*%*	*Therms*	*%*	*Coke oven gas*	*Coal gas*	*Carburetted water gas*
1939	6,302,700	44·7	7,811,400	55·3	54·3	42·3	3·4
1951	19,527,250	56·9	14,791,500	43·1	38·1	55·2	6·7
Increase equals		209·8		89·4			

It will be seen from this table that, during the 12 years, the demand from the pottery industry more than trebled while that from other consumers was rather less than doubled. Although an increased volume of coke oven gas has been made available, subject to an increase in price of 142 per cent. and still tending to increase, the deficiency has had to be made good by the increased manufacture of coal gas and carburetted water gas, both of which cost much more to produce.

Plant Extensions

To meet the demand, which emanated in the main from the pottery industry, the Stoke-on-Trent Corporation installed a new carburetted water gas plant, at a capital cost of £116,262, and undertook extensions to coal gas plant at an estimated cost of £626,625. In addition, expenditure amounting to £178,212 had to be incurred in providing extra holder accommodation. In view of the trend of consumption, the Board found it necessary to embark upon other plant extensions which are estimated to cost a further £1,500,000. It will be appreciated that, as the bulk of the new supplies will go to industrialists and be charged on the lowest points in the scale, the proper inci-

dence of the capital charges must be reflected at these points.

It will, therefore, be obvious that the provision of increased manufacturing capacity at the present inflated levels, coupled with the increase in prime costs have brought about a new situation, whereby, as time goes on, the difficulty with which the Board is confronted will be to maintain the present relatively favourable rates now being charged in the Stoke-on-Trent District.

A comparison of the prices charged in March, 1939, with current rates, is set out below:

Quarterly consumption Therms	*Net price per therm*		*Percentage increase*	*Current Sheffield price (net)*
	March, 1939	*Sept., 1951*		
	d.	*d.*		*d.*
19,001	3·40	8·0132	136	8·932
40,000	2·95	7·5395	156	8·506
75,000	2·75	7·3289	167	8·223
120,000	2·55	7·3289	187	7·995

It will thus be seen that the general percentage increase has only kept pace with the cost the Undertaking is now called upon to meet. As the deputation made a point concerning the prices charged in the Sheffield area, where a much greater percentage of coke oven gas is available than in Stoke-on-Trent, current tariff prices at Sheffield are incorporated in the above list for the purpose of comparison.

Flat Rate Increases

Flat rate increases were consistently applied up to Vesting Date by the Corporation of Stoke-on-Trent and this policy has been continued by the Board because the increased charges incurred have been of such a character that, in equity, they could only be applied at all points in the scale and not selectively. As a consequence, the percentage increase is larger when applied to a very low rate. Taking the pottery industry as a whole, the average price charged in 1938/39 was 2·9d. per therm, and in 1950/51, was 5·9d. per therm, which may be compared, as a matter of interest, with an average price to industrial consumers in the West Midlands Area of 9·78d. After allowing for the recent flat rate increase of 1·25d., the increase from 2·9d. to 7·15d. per therm represents an increase of 146·6 per cent. over 1938/39.

Section (1) of the memorandum records that: "The firing of all pottery ware in both biscuit and glost stages is the essential factor in production. These two processes together account for 40 per cent. of the total production costs of whiteware. The proportion of production cost attributable to fuels averages 5 per cent. in these operations."

If the above figures are correctly understood, it would appear that firing accounts for 2 per cent. of the total production costs of whiteware and, in order that the effect of the increase in the cost of gas may be judged in perspective, it is against this proportion that the increase must be evaluated. If, as might be inferred from Section (9), the proportion is 5 per cent., the fraction is still very small. The Consultative Council is aware that, by contrast, increases in the cost of coal, gas oil and other essential elements in gas production immediately affect a very high proportion of the total cost of production.

"Step" System

The present system of charge at Stoke-on-Trent is known as a "step" system, whereby all the gas consumed in any quarter is charged at the appropriate point in the scale. If a reduction of 1d. per therm was allowed to consumers taking 19,000 therms per quarter, and a marginal clause was inserted to avoid charging a larger sum for less gas, it would mean that no charge would be made for any quantity of gas from 16,308 to 19,001 therms per quarter. For example:

16,308 therms at present prices .. £555 4s. 10d.
19,001 therms at present prices less 1d. per therm .. £555 4s. 10d.

There are other specific points made

by the Federation which require an answer and these may be summarised as follows:

(a) Preferential Rates

The Consultative Council is aware of the provisions of the Gas Act, S.53(7), which provides that "an Area Board, in fixing tariffs and making agreements under this section, shall not show undue preference to any person or class of persons and shall not exercise any undue discrimination against any person or class of persons." In this particular case, the argument in favour of a concession is mainly based on the load factor but, apart from the special considerations set out in the succeeding paragraph, a point arises where commodity cost, plus an appropriate contribution to standing charges to avoid an undue burden on other consumers, precludes acceptance of the claim to a reuction.

(b) Constant Load

While the Federation correctly draws attention to the constancy of the load through 352 days of the year, a load of this kind has its own inherent disadvantages because it is necessary to have some 25 per cent. of the coal carbonising plant out of commission during 3-4 summer months for repairs, maintenance and reconstruction.

In order to provide the constant supplies, therefore, it is necessary to work the C.W.G. plant continuously when the carbonising plant is down for repairs. The cost of producing a gas of 475 B.Th.U.'s by this means is estimated, on present-day costs, to be 8·4d. per therm. This is actually higher than the lowest price of 7·3289d. per therm on the Stoke tariff and does not include purification, storage, distribution, capital, overheads, etc.

Furthermore, the peak demand at Stoke occurs between 11.30 a.m. and 12.30 p.m. on Sundays, when the distribution system is severely taxed. Considerable expenditure has to be incurred in enlarging mains and increasing pressures just for this short period, a position which would not arise to anything like the same degree if there was no demand from the pottery industry on Sundays.

It is pointed out in Section (3) of the Federation's case that the pottery industry settled in Stoke-on-Trent because of the availability of coal supplies and not because of raw materials but it will be noted that the advance in the cost of coal supplies has corresponded very largely with the increases in the cost of gas.

(c) Alternative Fuels

Section (10) of the memorandum states that electricity and fuel oil kilns are rapidly becoming more efficient but this applies equally to gas-fired tunnel kilns. Great advances have been made in their design and operation in recent years, not only in the reduction of heat losses from the kiln itself, but also in the utilisation of waste heat from the kiln for clay and ware drying and factory warming.

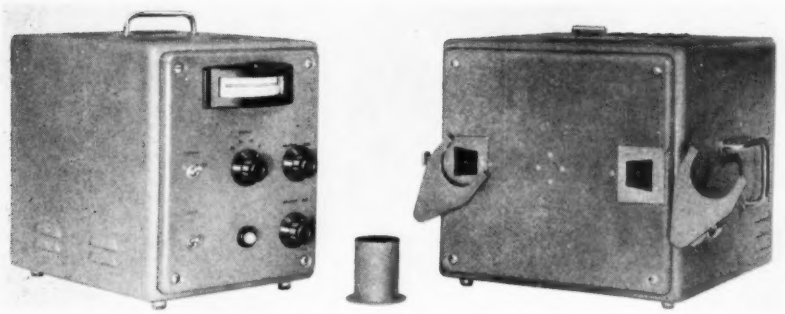
When assessing the comparative costs of fuel oil and gas for pottery firing, the capital cost of storage equipment, buildings, pumping and heating equipment, etc., and the maintenance and operation of same, should be taken into consideration. Additional supervision and maintenance is also necessary on the burner equipment.

In open-fired tunnel kilns, the ware would have to be protected from sulphur and carbonaceous matter by the introduction of saggars and the use of wadding between each saggar. This applies particularly to gloss firing, where a large number of tunnels are open-fired. Such methods decrease the efficiency considerably and offset appreciably the lower thermal cost of fuel oil as quoted.

There is a further question whether the reference to the fuel oil charge of 5·36d. per therm should not be 5·81d. (400-1,000 tons per annum). It is thought that the figure of 5·36d. refers to pitch/creosote mixture.

GAS SCRUBBERS

FROM the Power-Gas Corporation Ltd., comes a leaflet describing the several types of gas scrubbers which they make for cleaning gas on all sorts of plant from the dry ice plant to the blast furnace. From this leaflet it would appear that Power-Gas have solved the problems of gas scrubbing in a manner which covers all fields right down to the sub-microm dust. Copies of this leaflet can be obtained from the Power-Gas Corporation Ltd., at their Stockton-on-Tees works.



The Nash and Thompson colour comparator

A Unique Development Department

THE best of both worlds is always worth arriving at. Thus the Government research departments have almost unlimited resources of finance and technical manpower, but they lack commercial incentive, so that a visit to one of their laboratories cannot hide the dead hand behind the scenes. On the other hand the independent designer and consultant often suffers from the financial difficulty of keeping expensive departmental overheads with a wide variation of controls—he either has too much work and too few staff or vice versa.

At Nash and Thompson Ltd., Tolworth, Surrey, the research and development work for the Parnall Group of Companies, including Ascot Gas Water Heaters Ltd., is carried out, while simultaneously there is also instituted a widely varying consulting and development programme for many large and small firms, as well as Government departments.

The company was founded in 1936 and from then until 1945 was responsible for the design and development of the well-known Frazer Nash gun turret, as well as taking a leading part in the initial development of many types of radar scanner.

In 1945 it assumed responsibility for research into problems associated with design and development for the Parnall Group. Since that time its activities have expanded continually, and now it employs a staff of more than 100 technicians.

Broadly speaking Nash and Thompson Ltd., has developed a standard range of specialised scientific apparatus, whilst the company is also prepared to design and manufacture single instruments to suit users' special requirements, or to produce such instruments in small batches.

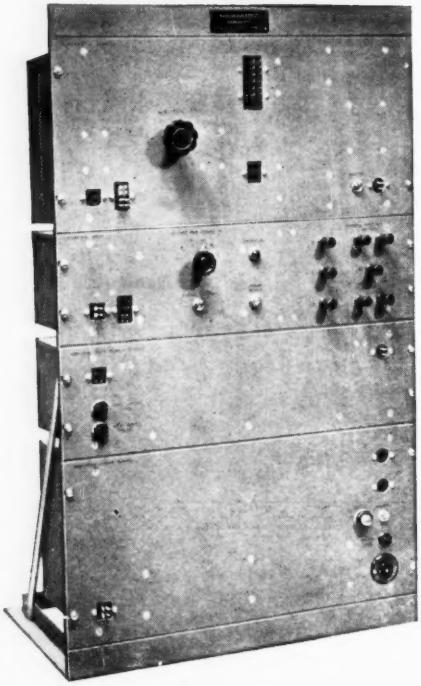
In addition they investigate and advise on scientific and industrial problems of all types, such as corrosion, electroplating, paint finishes, chemical and metallurgical analysis, colour matching and electronics.

For the purposes of description the 20,000 odd sq. ft. of building at Tolworth is divided as follows:

The Physics Laboratory

The physics laboratory is equipped for investigations in both classical physics and modern electronic techniques. Work carried out includes:

The calibration of thermocouples and platinum resistance thermometers, including the determination of sulphur, steam and ice points, and of mercury thermometers in constant temperature baths.



The Nash and Thompson multipoint rapid temperature recorder

Measurement of radiation by means of microthermopile and bolometer.

Dynamic balancing and surface analysis.

Optical testing and adjustment of lens and mirror systems.

Measurement of electrical components and calibration of electrical measuring instruments, in both audio- and radio-frequency bands.

Experiment in the combustion of coal gas and for other similar work generally handled in a Physics Laboratory.

Chemical and Metallurgical Laboratory

Here there is apparatus for qualitative and quantitative (volumetric and gravimetric) analysis, and is equipped for the determination of CO and CO_2 by infra-red absorption in addition to the standard methods.

Among other types of work which can be handled are: tensile and hardness testing of materials, including the determination of the hardness of rubber; determination of acidity, alkalinity and contact potentials; examination of metal structure; analysis of faults in metal samples by microscopic examination of mounted specimens; regular checking of components, materials, finishes and solutions for the purpose of maintaining manufacturing standards.

Engineering Laboratory

This is devoted to mechanical and general engineering, engaging in work relating to the simulation of temperatures at high altitudes, precision examination of gears, machined parts, scales, etc., by the shadowgraph method; determination of the factors in the design of anemometers, micromanometers and flue terminals; measurement of operating efficiency of refrigerating plant, water and space heaters and similar equipment in a constant temperature room.

A well-equipped design and drawing office is an obvious essential and likewise an up-to-date library of periodicals and technical works. Both are provided.

Machine and fitting shops are well equipped with measuring instruments and precision tools, including a jig borer. A wide variety of development on precision instruments and intricate mechanisms is performed here by skilled instrument makers, machinists and engineers.

The organisation is completed by an experimental shop and a pattern shop.

Of particular interest is the technical sales department responsible for handling enquiries, quotations, etc., which is familiar with both the commercial and scientific aspects of a problem.

Colour Comparator

Among some of the instruments so far developed may be included the colour comparator. This is an apparatus suitable for comparing the colours of slightly differing specimens of similar materials, if they are presented in the form of flat surfaces not smaller than 1½ in. square. Two beams of light from a single source are interrupted in opposite phases by a rotating shutter. The two surfaces to be compared (one, if desired, may be standard white) are illuminated by the two beams. Light reflected at 45° from each surface falls on to a barrier-layer photo-cell, which thus "sees" each surface alternately.

If the surfaces are not identical there is a flicker in the illumination of the cell which appears in its output as an A.C. component. This A.C. component is amplified and shown on a meter. The meter reading is then a direct measure of the difference in brightness of the two surfaces. Suitable meter ranges are provided and provision is made for inserting colour filters in the light beam.

The apparatus is at least as sensitive as the average human eye and has the merit of ascribing numerical values to slight differences.

Multipoint Temperature Recorder

The Multipoint rapid temperature recorder is designed to record the temperature indications of as many as twenty thermocouples when these temperatures are changing rapidly. The set of couples is "scanned" in 6 sec. so that the thermo-e.m.f. from each one in turn is fed to a "chopper" type D.C. amplifier. The amplified voltages are photographically recorded on a cathode ray oscillograph.

The photographic record appears as a series of vertical lines, the lengths of which are proportional to thermo-e.m.f., the scale to be used being established by feeding into the amplifier in one position of the scanner the e.m.f. of a thermocouple maintained at a constant known temperature. The time scale is obtained from the revolutions of the scanner.

In the standard model twenty test thermocouple stations are available, with provision for three "standard" thermocouples to set the scale of e. m. f. A certain flexibility is possible, as by halving the number of thermocouples and connecting each

one to two segments the effective speed of scan can be doubled. The maximum undistorted output of the instrument is 250 v. peak-to-peak and an oscilloscope with a suitable deflexion sensitivity must be used.

There is an interesting story behind this instrument, for recently the boiler tubes of a well-known ocean liner were failing by local overheating. Obviously speed was the essence of the problem, for it was impossible to lay up the ship for a long period. The multipoint recorder was hired to the shipping company and its twenty pyrometers were placed in contact with the tubes. A complete pictorial record of the temperature changes at various speeds and conditions, such as steam raising, was thus flown back to England.

By the time the ship returned full information for boiler modification had been gleaned from the results and the job was thus completed with minimum delay.

Furnace Controller

The furnace controller is designed to switch furnace and oven currents up to 15 amps. or to operate remote control valves in gas or steam-heated equipment. It has a temperature differential of 2° C. between 0° C. and 1,000° C. The control element is a platinum resistance thermometer in a wheatstone bridge circuit fed with A.C. The amplified output from this bridge is used to control the phase of the grid voltage of a thyratron valve, and by this means positive on-off switching of a relay in the anode circuit is obtained. The operating point is not affected by variations in mains voltage or frequency or by valve characteristics.

The main point to be noted about the activities of the Nash and Thompson organisation is its versatility—its ability to tackle fundamental problems from first principle. This versatility may be realised from a consideration of a range of non-standard instruments many on the "on-off" basis.

A *photo-electric controller* will control the pressure inside a container to within 10-4 in. w.g., and its rate of drift is less than 10-4 in. w.g. per hour. It compensates for a very abrupt change in the rate of withdrawal of air in about a minute, and for small step change without appreciable lag.

The basic part of this apparatus should have a wide applicability to a variety of control problems.

Considerable man hours, for relatively expensive technical staff, are saved by a *continuous chart planimeter* which measures the area below the line drawn on a continuous strip chart by a pen recorder.

A *paint abrasion testing machine* is used for the determination of abrasion resistance of paints and varnishes. It consists essentially of a fixed base for holding the test pieces and a sliding carriage carrying a vertical pin which rests on an abrasive loaded pad. This pad is driven to and fro over the test piece, and the strokes are registered on a counter. Weights are attached to the vertical spindle to apply the necessary pressure.

Pressures generated simultaneously by four different sources are recorded by a *high pressure recorder.*

A *holiday detector* produced for the Anglo-Iranian Oil Co. Ltd., is used for the detection of minute holes in the protective coating of steel pipe-lines before the pipes are buried in the ground. If these are not detected and filled, corrosion occurs at such pinholes and causes deterioration.

A *tidal breathing apparatus* simulates human breathing and was made for Admiralty tests on diving apparatus, while a *Multitube furnace* is used for investigating the corrosive properties of the combustion products of gas.

Eleven "Mullite" tubes are held at different temperatures, ranging from 100°-1,000° C. The specimens under examination are inside the tubes and over them are drawn the combustion products from a small gas flame.

The *lampadedrometer* was developed for an investigation into pinhole gas burners. It measures the time which elapses between ignition of gas at any two selected pin-holes.

From the foregoing it will at least be realised that problems of almost infinite variety are tackled daily by Nash and Thompson and in this respect the organisation is rather unique, offering something approaching the scope and work of American organisations such as the Battelle Memorial Institute at Ohio.

Transactions of the British Ceramic Society

THE following are abstracts of papers appearing in the issue of October, 1951:

Power Plant in the Heavy Clay Industries, by John Fox. Reference is made to drying requirements in the industry. The advantages and disadvantages of independent power plants are then discussed and particular reference is made to the utilisation of exhaust steam. Comments are also made on the operation of private power plants in parallel with the British Electricity Authority's grid. A section dealing with the relative merits of different types of prime-movers is followed by a review of modern boiler-house practice, as applicable to the industry. The four principal methods of mechanical stoking are discussed and some notes on boiler feed-water treatment are included.

The Behaviour of Firebricks on Reheating, by F. H. Clews, J. F. Clements and A. T. Green. The effect of oxidising and reducing furnace atmospheres on the behaviour of firebricks on reheating at 1,400° C. has been studied. If a reducing atmosphere is maintained throughout the test, a greater contraction or a smaller expansion results than would have occurred under oxidising conditions. Among the twenty-two brands of firebrick studied, there was no instance of an expansion being produced or increased by long-continued reducing conditions. The expansion of one brick was increased by a short period of reducing conditions maintained only while the temperature rose from 1,350°-1,400° C. Other bricks were practically unaffected by this treatment. The extra contraction produced by a change from oxidising to reducing conditions may be sufficient to make the result exceed an agreed limit. In some bricks the variation between individual test-pieces when tested under identical conditions is greater than that arising from a change in furnace atmosphere.

The Reheat Test, by F. H. Clews, J. F. Clements and A. T. Green. Two methods by which the occurrence of expansion in firebricks in the reheating test may be avoided have been studied. In the first, it is found that expansions can be prevented by testing the material under a small load, but it is impossible to choose a load which will check every expansion without causing excessive deformation in some materials. Expansions may also be avoided by testing at some temperature below 1,400° C. This would necessitate a reduction in the permitted length changes. It is found that the diversity of types among firebricks makes it impracticable to select a single temperature at which the test should be carried out. A double test in which duplicate specimens are reheated at 1,400°-1,250° C. respectively, allowing only a nominal length change at the lower temperature while retaining the present limits at 1,400° C., may be suggested as an alternative to the present test.

Variability of Reheat Behaviour, by J. F. Clements and G. R. Rigby. Forty-eight after-contraction tests have been carried out on each of nineteen brands of firebrick and the variability of the property has been evaluated. It is shown that an average value of reasonable accuracy can be obtained from a small number of tests in some brands, but in others twenty tests or more are necessary to ensure that the mean value of the results will be sufficiently near the true value for the batch. Range values corresponding to different degrees of variability have been tabulated so that the range between the highest and lowest values in a small group of tests can be used to estimate the number of tests required to give an average figure of known accuracy. A more accurate estimate of the number of tests can be obtained by calculating the standard deviation of the first results obtained. The errors involved in these operations are discussed.

Analysis of the variation in reheat behaviour within single bricks, between one brick and another within a batch, and in different directions in the same test-piece suggests that all three types of variation should be taken into account in sampling a batch of bricks for the reheat test.

A few measurements have been made of the temperature at which contraction begins in the reheat test. This temperature is found to be practically constant

within bricks which exhibit great variability in the measured length change.

Causes of After-expansion. by J. F. Clements and G. R. Rigby. Three possible causes of after-expansion in firebricks are discussed. They are (a) bloating, (b) laminar splitting or exfoliation, and (c) expansion of the solid material. An attempt to link up the occurrence of after-expansions in firebricks with some of their physical and chemical properties is described. It is found that the behaviour of a brick on reheating cannot always be explained by considering the proportions of fluxes present, the permeability, and the presence of the gas-producing materials, ferric oxide and carbon. It is suggested that some expansions may be due to the presence of a gas-producing agent, such as sulphur, which is not determined in the normal analytical procedure.

Experiments on an exfoliating clay are also described. Measurements have shown that the splitting of the clay grains, which is characteristic of this phenomenon, can cause an overall volume expansion of the grains while the clay material itself is contracting. In the clay described here, expansion by gas bloating also occurs at a higher temperature.

MODERN BASIC REFRACTORIES

UNDER the above heading, General Refractories Ltd., Genefax House, Sheffield 10, have issued a number of comprehensive leaflets.

The leaflets deal specifically with "Spinella A," a fired magnesite basic brick; "Spinella D," a chemically bonded basic brick; "341," a fired dolomite basic brick; "Saxpyre D," a chemically bonded basic brick; "Saxpyre," a fired chrome-magnesite basic brick; "Spinella," a fired chrome-magnesite basic brick; "Supermag," a fired magnesite basic brick; "Diazite," a fired chrome basic brick; "287," a chemically bonded chromite basic brick.

The chemical analysis of the various bricks are given, together with their physical characteristics referring to porosity (true and apparent), bulk density, specific gravity, permeability, specific heat, cold crushing strength, spalling index, after contraction weight per c. ft., and weight per thousand bricks.

The stand of Quickfit and Quartz Ltd. at the recent British Instrument Industries Exhibition, which featured a 200-litre vessel (the largest of its kind in the world) and interchangeable ground-glass joints

MECHANICAL CUP TURNING

by

TOM WATHEY

THE semi-automatic cup turning machine illustrated at Fig. 1 was originally developed to counteract the shortage of skilled hand turners in the chinaware industry during the immediate post-war years. At that time efforts were being directed towards re-establishment of the export trade, and a rapid expansion of pottery production was the order of the day.

From a purely economic standpoint even the earliest results indicated the desirability of such a machine. It was found that an unskilled female operator working alone could, after only a very short training period, turn out twice the output of the average skilled hand turner and his female attendant. In addition, the machine turned article had a superior finish, and a more uniform shape.

Turning of Earthenware

It may be added here that more recently it has become possible to use the machine in the turning of earthenware. Manufacturers of this class of pottery have found that their products can be given a better finish without any increase in operating costs. They have found, too, while keeping inside the limits set by their economy, that they could in many cases increase the range of shapes manufactured.

However, it should not be imagined from the foregoing that the mere installation of turning machinery will automatically rid the pottery manufacturer of his turning problems. Indeed, without the sympathetic co-operation of management and operative, results are almost bound to be disappointing. And in addition whatever the class of ware to be turned, complete satisfaction can usually only be obtained by close attention to earlier stages of production — the making stage in particular.

An Important Factor

The most important single factor in the machine turning process is the means whereby the article to be turned is held gently, but with sufficient firmness to withstand the action of tooling, and at a consistently uniform position relative to the cutting tools in use. In the machine under consideration this is accomplished by use of a specially designed vacuum chuck, Fig. 2. As will readily be understood, an individual chuck is necessary to suit each shape to be machined.

In practice, it has been found that some shapes are more easily machined than others, and it is recommended that initial trials should be made on shapes having a tapered or bell-like contour, rather than on those with a purely cylindrical outline. It must be stressed that while the latter shape can be satisfactorily processed, it is better to begin use of the machine by turning a shape which presents least difficulty to the untrained operative.

Design of the vacuum chuck allows of a limited amount of variation in the internal diameter of the article to be turned. Such variation may occur as a result of faulty tooling in the making stage, or again it may be due to differing amounts of moisture in the ware. This being so, it is obviously essential for the potter to aim at the highest possible uniformity in size and shape of the unturned ware. Hence, as will appear later, all ware offered to the machine must be produced by methods which will ensure uniformity within reasonably fine limits. It is, therefore, of the utmost

importance that the required *inside* shape and size of the unturned clay cups should be constantly maintained. Any variation will result either in the cups assuming a wrong position relative to the turning tools, or in making it impossible correctly to locate the cups on the vacuum chuck at all.

Accurate Making

Successful mechanical turning, then, begins in the making shop and, having arrived at a suitable setting of the jolley profile tool on the making machine, means should be adopted whereby the tool, securely mounted on its holder, can be refixed in its correct position relative to the inside of the mould as and when required. It is advisable too, to employ making tools of tungsten carbide, as these need not be removed from their holders for regrinding over reasonably long periods of time.

It might be thought that fixing up a jolley tool by "sighting" against the mould's interior would be sufficiently accurate. This is not the case. It should not be forgotten that the mould will increase in size during the period of its use, and this being so, it is clear that provided the making tool maintains its original setting, cups made in a mould will gradually become thicker as the life of the mould progresses. Such cups will, of course, be turned to standard *size* and *thickness* on the turning machine no matter what their *outside* diameter may be prior to turning.

Tool Setting

The first setting of a jolley profile tool is usually obtained by trial and error methods—using a *new* mould for the purpose. Then, a satisfactory result achieved, a model of the cup interior should be produced by filling

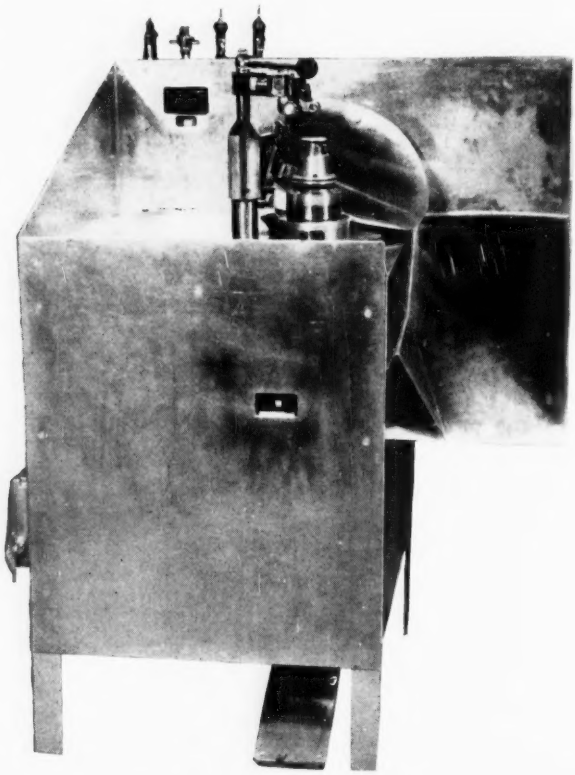


Fig. 1
The "Malkin" patent cup turning machine

it with plaster while still in the mould. In this connection, it may be necessary to treat the inside of the cup with a thin shellac preparation to prevent its collapse by absorption of water from the plaster.

It is from this mould that a "tool setting" mould is produced, having an inside form exactly similar to that required in the cup. Thus, by placing the "tool setting" mould in the jigger head, and resting the profile tool against it when the latter is being secured to its holder, a ready means is provided for correctly positioning—or checking the position of the tool—whenever this is necessary. However, as mentioned earlier, it should be possible for the tool in its holder to be refixed in its correct position on the jolleying machine at any time, using the "tool setting" mould only when it becomes necessary to remove the tool from its holder for servicing.

Turning tools, Fig. 3, supplied with the turning machine are of tungsten carbide, but despite the almost diamond hardness of this material the abrasive properties of the average clay body are sufficient to break down the tool edge to the re-grinding stage after processing 1,500 by 12 pieces on the average. In this connection, it should be mentioned that tungsten carbide tools can only be formed or re-sharpened by the use of diamond impregnated grinding wheels, and a fine or superfine grade of wheel is needed if a clean cutting edge is to be produced. Hence, grinding of such tools is a job for an experienced craftsman, and would-be users are advised to ascertain if facilities for servicing the turning tools are reasonably close at hand. It should also be noted that preparation of the initial tool outline is a job for an expert, and this is usually best tackled in co-operation with the machine makers.

Possibilities

It is outside the scope of this article to describe the functioning of the turning machine illustrated. But a few notes on the possibilities of mechanical turning will doubtless be of interest. The machine's proportions were determined by the dimensions

Fig. 2. The "Malkin" patent vacuum chuck for use on the cup turning machine

required in accommodating a complete range of cups from coffee to breakfast size. However, recent experiments have proved that what may be termed "outsize" articles, such as beakers up to 5 in. tall, and bowls not exceeding 6 in. dia., may be successfully processed on the machine. It can, in fact, be shown that the new technique of mechanical turning is established to such an extent that no great stretch of the imagination is needed to forsee its adaptation to a very wide range of pottery articles, and experiments to this end are in continuous progress.

Acknowledgments and thanks are due to F. Malkin and Co. Ltd., Ceramic Engineers, Longton, for their co-operation in the production of this article; and from them further information on the subject may be obtained is desired.

DEWRANCE & CO. LTD.

JOHN F. McKEE, Ardmore, Pennsylvania, has been awarded a Certificate of Merit by the Franklin Institute, Philadelphia, for his development of a small, lightweight steam trap known as the "Yarway" impulse steam trap.

The Commonwealth and European rights for this trap are vested in Dewrance and Co. Ltd., London.

Fig. 3
A tungsten carbide tool assembly

SOME ASPECTS OF RESEARCH

A Visit to the Laboratories of the General Electric Company Ltd.

ON Monday, 22nd October, members of the Pottery Section of the British Ceramic Society paid a visit to the G.E.C. laboratories at Wembley. The attendance was round about sixty and a whole day was spent on the visit, members of the Society being entertained to luncheon by the directors of the Company. It was a happy thought on behalf of the secretary, Dr. W. L. German, for it did give members a chance to see that there was a terrific volume of ceramic research proceeding by this private enterprise group.

The G.E.C. research department is probably the largest centralised one in this country, with a staff of about 1,700. Visitors could not but help being impressed by the air of activity surrounding this research body compared with similar large State-sponsored organisations.

The reason for this lies undoubtedly in the close liaison maintained by the research department as such, and the corresponding industrial productive unit. For example, each team of research workers has its programme laid out by a committee representing the productive units of the G.E.C. Ltd., for which they are working themselves. Thus a research worker is constantly impressed with the necessity of carrying out work which is brought as near to direct industrial application as possible.

Their activities are directed along realistic lines and from a discussion with members of the laboratory, one gathers that there is an overall percentage of about 10 per cent. directed towards fundamental research whilst the remainder is towards immediate industrial problems. It is in this close liaison with production that so many Government research departments find themselves handicapped and their research programme less realistic in approach.

This research organisation really began in 1916 under the influence of Sir Clifford Patterson, O.B.E., D.Sc., F.R.S., who came from the National Physical Laboratory.

Today the floor area is nearly a quarter million square feet, employing about 1,700 staff of whom fifty are classified as leaders in their respective fields, and about 250 are highly qualified men.

There are more than 100 specific departments so that the visitors were wisely restricted to some of the

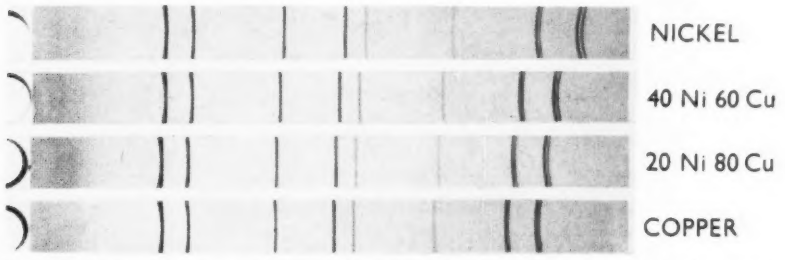


Fig. 1. X-ray diffraction patterns of pure metals (copper and nickel) and alloys, showing the type of pattern obtained from solid solutions

laboratories of interest in their particular fields.

The Refractory Laboratory

The growth of the refractory laboratory is interesting. The company found it necessary to produce their own glass to their own exacting specifications for valves, etc., and production problems caused them to pay attention to refractory development. Visitors saw a number of tests which were employed in the development and production of these refractories, largely used in glass manufacture. They saw research results leading to

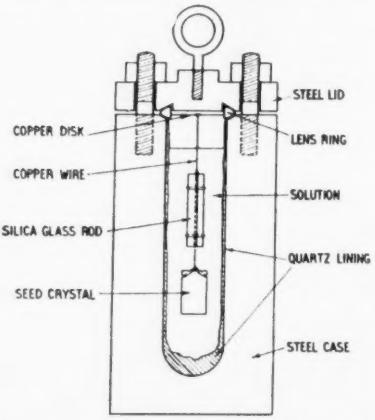


Fig. 2. 500ML. bomb for synthesising crystalline quartz

some correlation between the creep of refractories at high temperature and their corrosion resistance. They saw new refractories which had been produced by the G.E.C. which were claimed to be better than proprietary products.

In the glass technology departments they saw the extensive work which had been done on the problem of metal to glass seals and saw how batches of 300 gm. initiated a first glass batch followed then by 50 lb. batches then by 1 ton batches until the process was handed over to production. A novel method of determining comparative corrosion resistance of refractories used in glass manufacture consisted of a paddle of the refractory maker as under test stirred in molten glass which enabled one refractory to be tested against another.

Visitors were impressed by the demonstration of the development of fluorescent lamps, particularly by the wide variety of colours, which are now available largely due to the pioneering efforts of G.E.C. on fluorescent pigments. The replacement of beryllium compounds which are relatively unsafe by the halogen phosphates which had better light-giving properties with increased safety to the operator was noted.

The problem concerning production of quartz plates for oscillators was examined and the steps taken to produce thin windows of quartz a fraction of a millimetre in thickness was seen as well as the results of growing quartz crystals themselves as a replacement for the natural product.

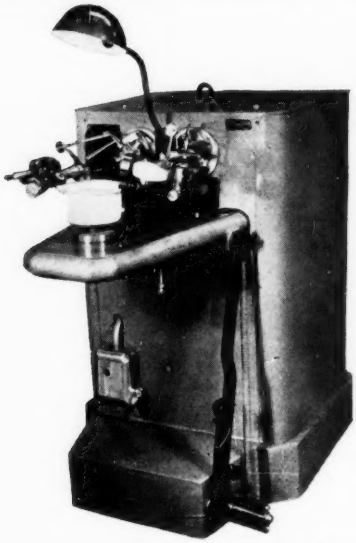
The department dealing with synthetic sapphires proved equally interesting.

It is impossible to deal in detail with these various aspects but certain high spots are worthy of further mention.

The analytical department has fast grown beyond orthodox chemical analysis.

Visitors were explained the value of X-ray diffraction patterns, it being pointed out that most materials have sufficient crystallinity to give a characteristic pattern and since no two pure chemical compounds have the same atomic arrangement, and as the diffraction pattern depends upon the atomic architecture the method can be used to identify chemical substances providing there is sufficient number of standard patterns available. Obviously the number of different patterns is legion and in such an examination the work can be narrowed down by the use of the spectrographic test which restricts the research to compounds of those elements detected by the spectrograph. Fig. 1 shows X-ray diffraction patterns for pure metals and an alloy.

The development of synthetic quartz for use in oscillator plates for the control of radio frequencies is derived from the earlier work of Spezia in Italy; the process is carried out in a bomb capable of withstanding a thousand or more atmospheres in a temperature range of 350°-400°. Here the composition of the solution and its purity as well as the pretreatments of the seed are most important. The



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silica glass to replenish the solution is in rod form. Fig. 2 shows diagrammatic representation of the bomb.

The use of synthetic sapphires as jewelled bearings was once the prerogative of Switzerland as well as France and Germany but the World War II caused work to be directed towards their production in Britain.

As is well known, the synthetic sapphire is a misnomer for the manufactured stones are purer than the natural ones whilst they contain fewer mechanical and crystallographic imperfections. The process first used was a development of Verneuil, published in 1904.

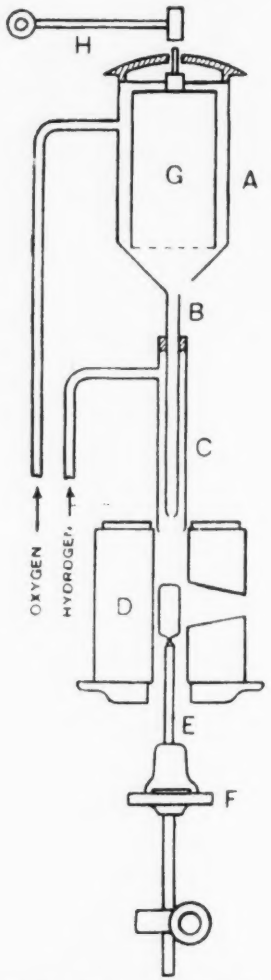

Fig. 3. Diagram showing a typical sapphire boule.

The alumina oxide used is a fine free-flowing powder prepared by igniting ammonium alum. This is fed through an oxy-hydrogen flame causing it to fuse and solidify thus building up a stalagmite on a refractory support. Fig. 3 shows the apparatus diagrammatically.

Oxygen is fed by a pipe into the hopper *A*, which is extended downwards by a vertical tube *B*, ending in a jet. Surrounding this tube is a larger one, *C*, into which hydrogen is fed, so that *B* and *C* together form an oxy-hydrogen blowpipe. The flame is directed downwards into the cylindrical central hole through the refractory brick, *D*, which for convenience is split vertically into two similar sections. A refractory "candle," *E*, projects into the furnace so formed, and can be raised or lowered by adjusting the height of the table *F* which supports it. Fine alumina powder is placed in the suspended canister, *G*, the lower end of which is closed by a fine wire gauze cap. After the burner has been lighted, the small hammer *H* is set in motion so that it is lifted and allowed to strike the peg beneath at intervals of 2-3 sec. At each blow, a small amount of powder falls through the gauze and is carried downwards in the oxygen stream. The alumina is melted in passing through the flame and is caught on the top of the candle *E*, which is in a cooler part of the furnace. Here a cone of sintered material builds up and, as the temperature rises, the apex melts and forms a very small spherical globule to which the next layer of falling powder is added. As the height of the globule grows, the lower part is screened from the flame and solidifies. The sphere becomes a stem, the cross-section of which may be increased as growth proceeds. This is achieved by supplying more heat until the growing crystal resembles a mushroom. After a further period the increasing heat supply is checked, and the boule grows upwards without further increase in diameter. Finally, the powder feed is stopped, the gas supply is cut off, and the boule is allowed to cool in the furnace.

The resulting solidified mass or

"boule" shown in Fig. 4, is about 50/60 mm. in length and 20/25 mm. in dia. and weighs about 2 oz. When this is given a sharp blow it splits roughly into halves. When these split jewels are used for jewel making the wastage is in the neighbourhood of 90 per cent. This caused work to proceed upon the development of a rod process. Again pure alumina is fused and deposited in the oxy-hydrogen flame to build up a rod. The burner was scaled down and the powder applied to give a growing rod of about 3 mm. in dia. The rod was lowered mechanically at intervals and it was found that it was desirable to lower the rod at exactly the rate at which it was growing. By focussing the image of the white hot top of the rod on to a photocell, any change in the position of the rod tip changed the illumination of the photocell and altered the photo-electric current. These changes were amplified and used to energise the starter of a motor which lowered the rod until its tip was restored to the correct position. From this material jewels are produced of 2 mm. dia.

Another development has been the photo-electric temperature measurement for the glass industry.

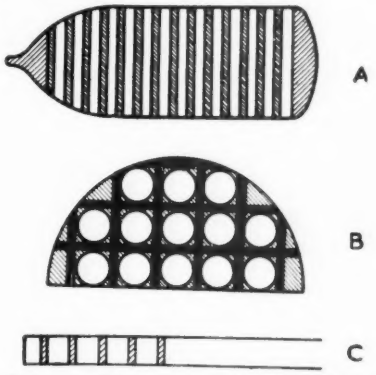

Fig. 4. Diagram showing how jewel blanks are cut from half boules and rod. (a) Normal boule; (b) cutting jewel blanks from boule 3 mm. squares; (c) cutting jewel blanks from rod. (Shaded areas represent waste)

A WARE SIZING MACHINE

REPORT BY A USER

IT is often found desirable to separate runs of any given size of plates, saucers and similar articles into various sub-divisions of sizes, for the purpose of correct fitting of prints or transfers. It is well known that a 10 in. plate, particularly from coal-fired intermittent ovens, will vary in actual size according to its position in the oven, and even from oven to oven. Many methods of sizing these articles as required are in use, but most of them are slow, laborious and by no means accurate.

During the last year, a machine has been in use at one of the leading potteries, which has performed this job satisfactorily, saving time and trouble, and a description of it would therefore appear to be of interest.

The ware sizing machine by Potteries Die Co.

The machine, manufactured by the Potteries Die Co., High Street, Norton, is a development of the tile-sizing machine made by this firm, and already in use throughout the industry. It was seen to possess possibilities for adaptation to the earthenware and china trade, by W. T. Copeland and Sons, at whose request the machine was made.

The machine is portable from place to place, weighing about 75 lb. It consists of a metal frame with a narrow inclined front, in the centre of which is positioned an adjustable spring-loaded slide. In a central slot in the slide, is positioned the lower location unit, which consists of a metal plate which can be moved to any position up or down the slide and quickly locked. This is faced with plastic and also carries a V-shaped block of wear-resistant plastic material. At the top of the slide, and mounted on the metal frame, is a spring-loaded piston, carrying a straight-edged plastic block mounted on plastic faced metal. The distance between these two blocks is the actual distance measured by the machine when in use.

The upper movable piston is operated by the insertion of a plate between the two blocks which automatically causes the movable abutment to move over a series of electric contacts, and when finally in position and not before, a light appears in one of six indicating lamps under an arc in front of the machine into which letters or numbers can be placed. In the case of the letters "A" "B" "C" "D" "E" and "F" being used, then assuming that "C" is decided upon to be the "dead size," lamp "B"

lights if the next plate is $\frac{1}{32}$ in. less, and "A" if it is $\frac{1}{16}$ in. less than standard. Also "D" $\frac{1}{32}$ in. larger, "E" $\frac{1}{16}$ in. larger and "F" $\frac{3}{32}$ in. larger than size. In the case of the machine in use, the letters are arranged in the order "C" "D" "E" "F" "G" "H," with "E" being used as the standard.

The method of operating is as follows:

A standard plate is decided upon, and this is placed flat on the inclined front of the machine in contact with the top block. The lower V-shaped block is then slid up to contact the plate, which now has tnree single points of contact. The lower block having been fastened and a locking nut loosened at the bottom of the adjustable slide, a knurled knob is slowly turned to give fine adjustment until the indicating lamp "C" is lit or any other selected lamp. There is also a small pilot lamp positioned on the indicator, which is switched on separately to set this standard size, so that contact for the selected light is set in the exact centre of the position, in which case this pilot lamp is lit. This light is then switched off, the locking nut tightened, and the plate removed, the machine being ready to operate.

Any plate now placed between the two contacts which is within the $\frac{1}{32}$ in. limit of the standard will cause the light "C" to show immediately it is positioned, and a plate which is $\frac{1}{16}$ in. larger will immediately cause light "E" to show and so on. The plates are slipped into position quickly and easily from waiting bungs, and placed on the appropriate piles "A" to "F" as they are withdrawn, or possibly into two piles "A" "B" "C" or "D" "E" "F" according to the limits of size required.

This machine has been operating for one year and has shown no signs of wear and has had no mechanical breakdowns during that time.

A further point of interest is, that by means of a specially designed master switch, dazzle due to the movable abutment running over the contacts and causing each light to flash in turn is eliminated, as no light appears until the plate is actually in position. It should also be stated that on the present machine the minimum and maximum sizes which the adjustable slide can take is from 3 in. dia. to 12 in. dia.

The machine is manufactured to operate on 230 volts A.C. and has a separate transformer unit for mounting on the wall out of reach of the operator, with a trailing cable carrying only 8 volts low tension, so that there can be no danger to the operator should the cable be damaged or any other electrical mishap occur.

There appears to be no reason whatever why the variation of $\frac{1}{32}$ in. should not be replaced by any given variation to suit the requirements of any firm, and the single V-shaped lower block of the machine under review has successfully taken all sizes of articles measured by the machine without a larger or smaller block having to be used for the various sizes.

The wear on these blocks has been slight, and in any case is automatically allowed for each time the machine is re-set to the standard plate so that accuracy is obtained irrespective of the wear on the block.

Acknowledgment is made to Mr. R. R. Hollowood of the Potteries Die Co., for permission to use much information contained in this article, and for the interest shown in developing this machine.

AN ELECTRO-MECHANICAL CONVERTER

THE problem of measuring chemical quantities electrically and indicating results at a distance has always an extreme value and the research laboratories of the General Electric Co. Ltd., and Salford Electrical Instruments Ltd., announce a new converter.

Typical of the many industrial applications are the measurement of gas, liquid and steam pressures, liquid levels, the determination of compression and tension in girders, props, ropes, wires, or struts; the determination of the weights of large and small structures; load indication of cranes, hoists and lifts; valve indication at remote points, measurement of temperature elongation, and instantaneous explosions caused by steam hammers and pile drivers.

The instrument operates on A.C. and

the indication can be transmitted over several miles. Basically the instrument works on the principle of a change in the inductance on a circuit and many of the previous errors in earlier change of inductance systems have been overcome by using a magnetic powder material "Gocalloy PL." The powder is moulded and used as the magnetic circuit of an electro-mechanical transducer which may be regarded as an electrical transformer with a core moved by the originating mechanical force.

The primary winding of the transformer is connected to A.C. mains through a step-down transformer, and the secondary winding is connected to a special dynamometer-type indicator.

This new system is claimed to be extremely simple and robust and can be operated and maintained by unskilled personnel.

It is important to note that the combination of the converter unit and this special instrument is necessary to give an electrical performance that is independent of A.C. mains voltage and frequency fluctuations. Hence neither the converter nor the instrument have practical applications when used separately. The electrical system is, in effect, a method of measuring mutual inductance of the converter in which the instrument movement and electro-magnet are an essential part of the circuit.

Although the equipment described above deals with the converter unit as a separate entity, certain types of mechanical equipment, such as pressure gauges, are being manufactured or developed, with built-in converters. In those instances the electrical equipment is supplied separately so that it can be adapted by the user.

ADVERTISERS' INDEX

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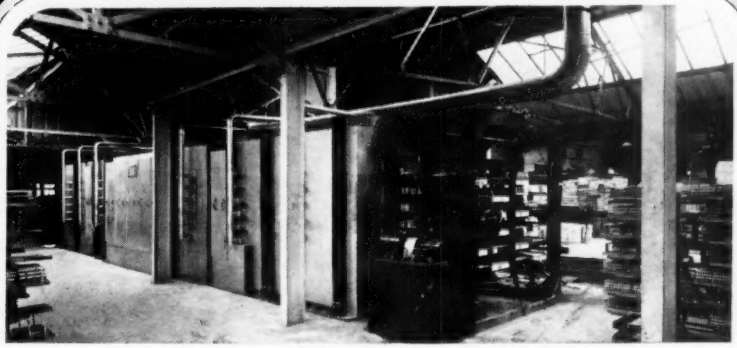

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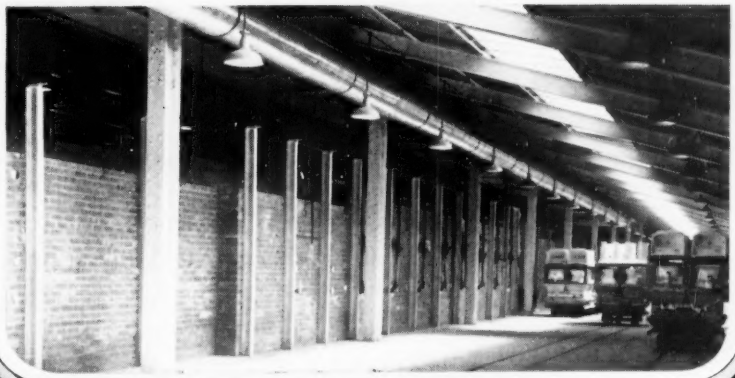

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